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TRANSACTIONS

Kansas Academy of Science.

VOL. X.

1885-86.

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TRANSACTIONS

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OF THE

EIGHTEENTH AND NINETEENTH ANNUAL MEETINGS

OF THE

KANSAS ACADEMY OF SCIENCE,

(1885-86,)

WITH THE

REPORTS OF THE SECRETARY.

VOL. X.

TOPEKA, KANSAS:
KANSAS PUBLISHING HOUSE: CLIFFORD C. BAKER, STATE PRINTER.
1887.

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A. H. THOMPSON, *For the Committee.*

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President—E. L. Nichols.

Vice Presidents—J. D. Parker, N. S. Goss.

Secretary—E. A. Popenoe.

Treasurer—I. D. Graham.

Curators—F. W. Cragin, N. S. Goss, Geo. S. Chase, E. A. Popenoe, and A. H. Thompson.

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BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

During the past two years Mr. E. P. West has been assisting the writer in the collection of geological specimens for the University cabinets. In the month of August, 1885, he was so fortunate as to discover, near Thompson's creek, in Ellsworth county, Kansas, a single well-marked impression, which I believe to be a genuine bird-track. The piece of rock containing the impression was picked out from a pile of material which had been removed from a well excavation 44 feet in depth. This well was sunk in the Dakota sandstone, and the geological horizon of the bird-track is about 200 feet below the upper level of the Dakota rocks. The horizon of the bird-track appears to be identical with that of a fine series of dicotyledonous leaves obtained on Thompson's creek, at a distance of about a mile and a half from the well.

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This impression appears to have been made by the left foot of some bird with

elevated hind toe just reaching the ground at its extremity, as in the modern snipes and other wading-birds, or in the family of sea-gulls and terns. That the track is probably that of a right foot rather than a left, is indicated by the wider separation of the outer toe from the middle toe, resulting from the greater versatility of the outer toe as compared with the inner toe — a character illustrated in many families of existing birds, and carried to an extreme in the cuckoos and the woodpeckers, in which the outer anterior toe is entirely reversed in its direction and becomes a backward-pointing member.

It will be seen from the accompanying cut that our bird-track exhibits the imprint of all four of the toes. The outer anterior toe is represented for fully two-thirds of its length. The middle and inner anterior toes are entirely impressed, even to the claws at their extremities—the claw being very distinctly marked upon the middle toe. The ball of the foot has left a deep impression, and the posterior toe has made an unmistakable imprint upon the sand similar to those made at the present time by birds whose hind toes just reach the ground. That this impression is avian in its character rather than reptilian, is evident from the imprint of the hind toe, for no dinosaur or other reptile, either recent or extinct, is known to have a backwardly directed toe. Some dinosaurs have a fourth small or rudimentary anterior toe, but in no case has a posterior toe been discovered. The absence of the impression of a posterior toe in the so-called bird-tracks of the Connecticut river Triassic sandstone has led the best authorities to consider those tracks reptilian rather than avian. The small size of our Dakota track is a confirmatory indication of its avian character. It measures only two inches from anterior middle claw to claw of posterior toe, being a little larger than the foot of Professor O. C. Marsh's *Ichthyornis victor* as restored by him in his famous monograph of the Odontornithes. The restoration of the foot of *Ichthyornis*, however, was based upon a single phalangal bone, the only portion of the foot yet found, the rest of the skeleton of the foot having been restored in exact imitation of a living species of tern, which among recent birds *Ichthyornis* seems most closely to resemble.

The discovery of this avian footprint in the Dakota rocks considerably lowers the geological horizon of Kansas birds. The Niobrara group of the Cretaceous has hitherto furnished all our knowledge of ancient bird-life in Kansas. From these

rocks was obtained nearly all the material for Marsh's magnificent work upon the "Toothed Birds." This is the highest Cretaceous group represented in Kansas, the Benton and the Dakota lying beneath it. The Dakota rests unconformably upon the Permo-Carboniferous rocks, with apparently an entire exclusion of the Triassic and Jurassic formations. The evidence of the existence of bird-life is thus extended down from the highest to the lowest division of the Kansas Cretaceous, and if Professors Mudge and St. John are correct in maintaining the absence of the Triassic and Jurassic formation in our State, this evidence cannot be extended lower down in Kansas, unless we admit the somewhat improbable suggestion that the class of birds existed in the Paleozoic time.

The discovery of this Dakota bird-track enables us to supply an important element hitherto lacking in that earliest of Cretaceous eras. The wonderful luxuriance of the land vegetation of the Dakota and its marvelous similarity to the dicotyledonous forest growths of the warm temperate climes of the present day, have rendered these sandstone beds a most fascinating field of investigation for both Paleo-botanists and Neo-botanists. The finely developed and perfectly preserved foliage of Oaks, Willows, Poplars, Laurels, Sarsaparillas, Magnolias, Sassafras, and other kindred forms belonging to genera now long extinct, have hitherto suggested a beauty of landscape whose perfection was only marred by the apparent scarcity of animal forms. It is true that these fossil leaves give abundant evidence that the vegetable kingdom was subjected in those ancient times to the attacks of injurious insects But our imaginations require the presence of more conspicuous animal forms to harmonize with the extremely luxurious development of vegetable life. Our bird-track supplies the missing element of graceful aërial forms. From the size of the footprint it may be safely inferred that the bird which left it was somewhat larger than a pigeon. It was probably a bird with teeth, in that respect resembling its predecessor the European *Archæopteryx* of Jurassic times and its successors of the Middle Cretaceous, the *Hesperornis* and the *Ichthyornis* of the Niobrara group. If our Dakota bird was an *Ichthyornis*, as is by no means improbable, its habits were doubtless similar to those of the modern Tern.

Prof. Marsh writes of the *Ichthyornis* that "its sharp cutting teeth prove beyond a doubt that it was carnivorous. Its great powers of flight, long jaws, and its recurved teeth, suggest moreover that it captured its prey alive. Its food was probably fishes as their remains are found in great abundance mingled with those of *Ichthyornis*. Besides *Ichthyornis* and its allies, the only other denizens of the air at present known to have inhabited the same region were the toothless Pterodactyls. The *Ichthyornis* doubtless competed with these huge dragons for the fishes in the tropical ocean about which they lived."

The distribution of land and water in Kansas during the formation of the Dakota sandstones was of such a character as to favor the belief that our bird was either a wading-bird, or allied to *Ichthyornis* and the modern Terns. The occurrence of the fossil leaves in restricted areas shows that the land was in the form of islands of limited extent, while the marine character of the fossil shells indicates that these islands were surrounded by a salt-water ocean.

While a student at the Agassiz School of Natural History on Penikese Island off the coast of Massachusetts, the writer took great pleasure in watching the large flocks of Terns which had established their breeding-grounds upon a portion of the island. These beautiful birds, with long and narrow wings, were continually performing their graceful evolutions in the air in search of food in the ocean for themselves and their young. It was a rare occurrence to see these birds alight upon the shores of the island. They consequently left few tracks upon the sand. From "early dawn

to dewy eve" they were incessantly upon the wing, exhibiting a dash and buoyancy of flight unknown to other birds. In the protection of their eggs and young they exhibited unmistakable promptness and valor, swiftly descending along graceful but vigorous curves to a perihelion point in uncomfortable proximity to the face and eyes of the intruding naturalist.

The birds of the Dakota period were doubtless even more active than the Terns of the present day. The probable presence of teeth in their jaws was an advantage evidently employed with disastrous effect not only to the fishes which constituted their food, but also to their rivals and enemies — the flying reptiles without teeth. The latter were overcome in the conflict, and teeth are no longer a necessity to birds.

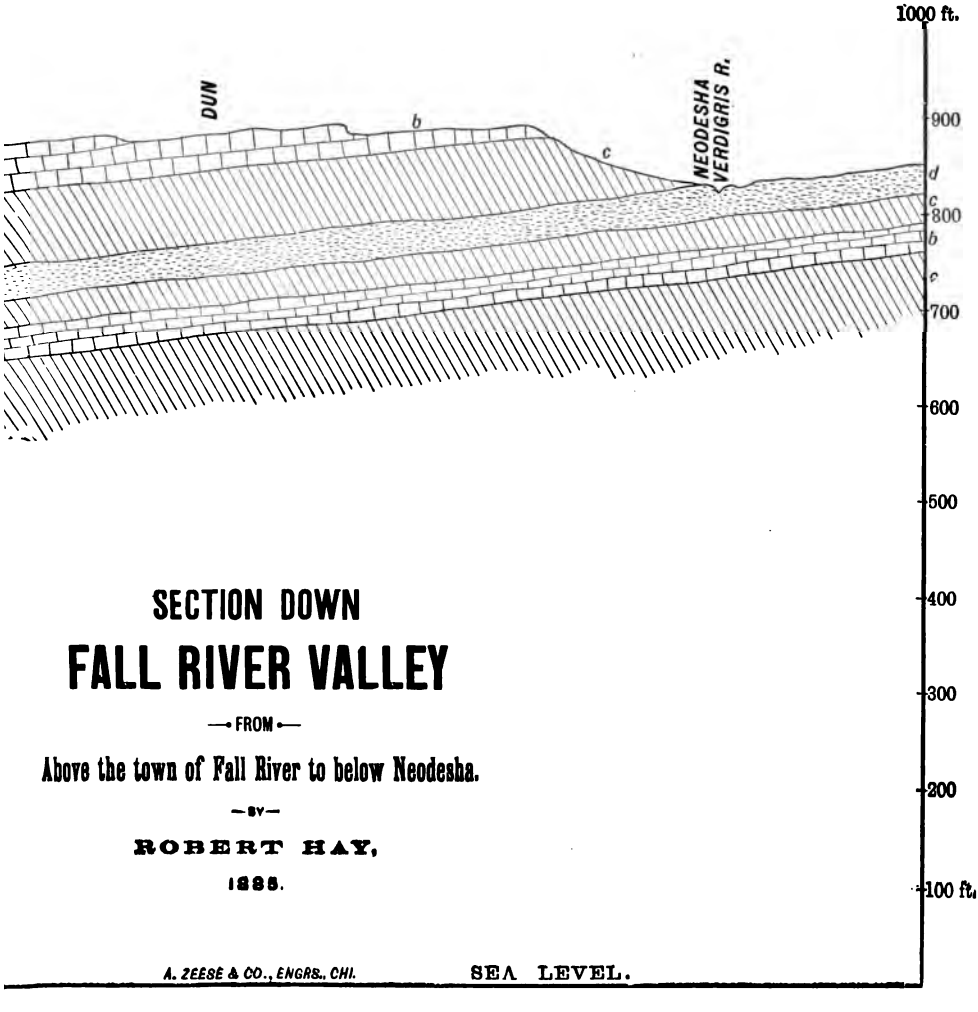
It is hoped that the discovery of our bird-track may stimulate search for other tracks, and that the evidence for the existence of birds in the Lower Cretaceous may not long depend upon a single "footprint upon the sands of [the Dakota] time."

A GEOLOGICAL SECTION IN WILSON COUNTY, KANSAS.

BY ROBERT HAY, OF JUNCTION CITY, KANSAS.

In April, 1885, the writer was called upon to make some investigations for a coal company in the southeast corner of Greenwood county, and after so doing, spent some time east and south down the Fall river valley, nearly across Wilson county. Some observations were afterward made northwest, about Eureka, but as there was a break in the continuity of the explorations, the last are not noticed in this paper. The general result of the connected observations is the construction of a section parallel with the course of Fall river from the town of that name to a few miles east of Neodesha, in Wilson county. The thicknesses of strata in the western part were obtained by actual measurements both with tape-line and instruments of precision, and the others were carefully estimated from comparisons with the elevations of the San Francisco Railway, kindly supplied by Jas. Dun, Esq., the engineer of the company, and from the actual depth to which the strata have been penetrated by wells, as well as by measurements of precipitous bluffs. In one place a certain stratum was suspected to be merely a local intercalation, a substitute for part of another stratum; but as this could not be satisfactorily determined in the time at my disposal, the stratum was left in its place in the section till further investigation should support or throw out its claim to be considered as an addition to the general thickness of the formations. It does not, however, affect the result to a greater extent than two per cent.

The principal points which the writer would note in connection with this section are, (*a*) the evidence as to the average dip, and (*b*) the indications of disturbance of the strata. From Neodesha to Fall River, a distance of twenty-eight miles, the ascent of the Frisco railroad is 124 feet, but these stations are separated geologically by a vertical distance of 405 feet, the former place being situated about on the upper horizon of the Neodesha sandstone, and the latter in a similar position to the Fall River sandstone. This leaves the difference, 280 feet, to be accounted for by the westerly dip, which is therefore about ten feet to the mile. But this average dip, greater than is found in most parts of Kansas, is by no means uniform through the distance surveyed. A carefully measured mile at the western extremity of the section gave a dip of 45 feet, and in a quarry about two miles east of the town of Fall River the sandstone ledges were inclined to the horizon at an angle of more than ten degrees.



SECTION DOWN
FALL RIVER VALLEY

—FROM—

Above the town of Fall River to below Neodesha.

—BY—

ROBERT HAY,

1885.

A. ZEESE & CO., ENGRS., CHI.

At this point (the quarry), the bluffs on the opposite side of the river are within half a mile apparently with a dip in a different if not opposite direction. In a valley beyond these bluffs is the outcrop of a ledge of limestone whose position is most easily explicable on the supposition that there is here a fault, an absolute dislocation of strata with considerable vertical displacement, but it will need further examination to verify this.

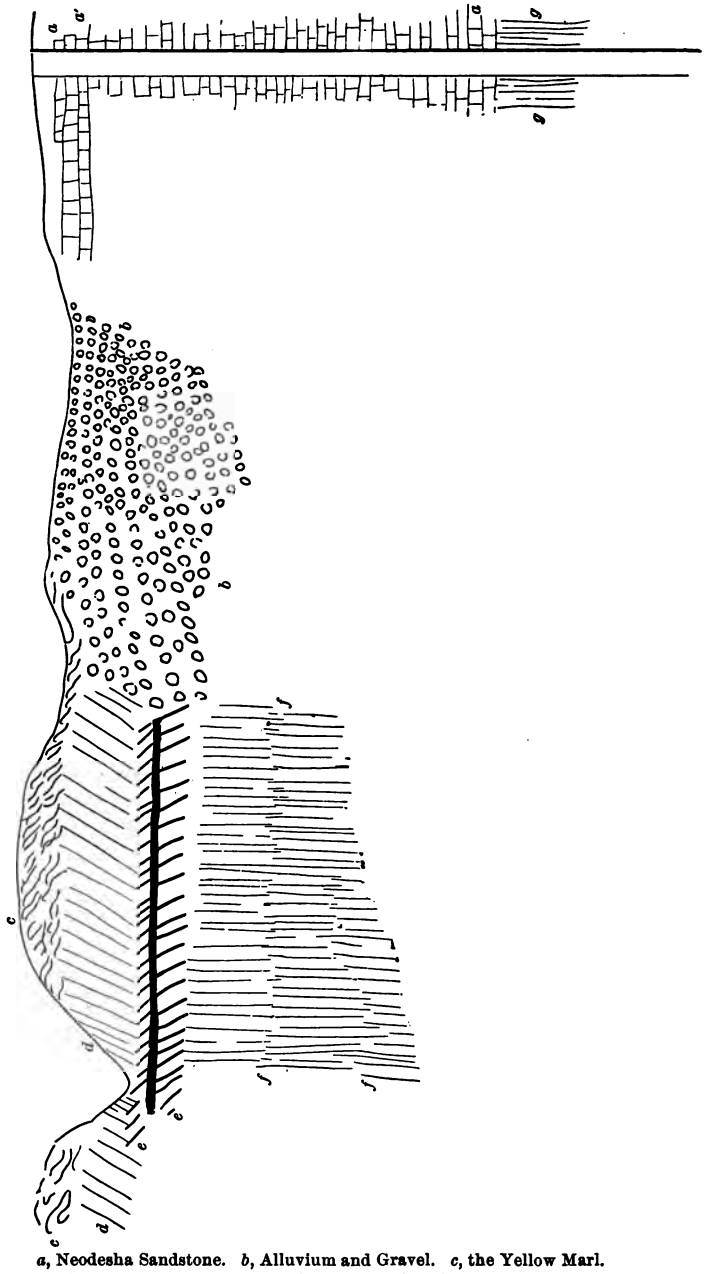
At Neodesha, near the mill, there is a fracture which gives a displacement which cannot be less than thirty vertical feet; how much more, remains to be proved. Its direction also will have to be determined by future exploration. There is very little dip to be seen on either side of the fault in the exposure examined, but it may be that that is owing to local direction of the strike. The diagram on the following page illustrates this fault.

In the neighborhood of the mound near New Albany there are also indications of displaced strata, and there is a well in the district from which has escaped a considerable amount of gas, which would be expected in a faulted region of the coal measures.

The massive sandstone of Fall River, eighty-five feet thick, produces now much valuable building-stone, and may be expected to yield still more with further examination of the large area of its outcrop. This is also true of the Neodesha sandstone, which, near the fault described above, has some of its mass as hard as and of the texture of quartzite. Salt (brine) also is found in connection with the former layer. The identification of these strata across the divides into the valleys of the Verdigris and Neosho would be of practical value, as they appear to be persistently definite horizons for considerable distances. The immense bed we have called the Dun limestone is probably the same as the thick Humboldt limestone of the Neosho valley. It has the same irregularity of structure and apparently the same fossils. In one district southeast of Fredonia it yields the finest crinoids hitherto obtained in the coal measures of Kansas.

The writer cannot forbear expressing the wish that the Academy should undertake the work of making a section of the valley of the Fall river, as it appears to be the steepest and deepest in the State, Neodesha being nearly one hundred feet lower than Oswego in the valley of the Neosho; and the headwaters on the confines of Butler and Greenwood counties come from an elevation of about 1,600 feet, where the Flint Hills culminate.

In closing this paper we will call attention to the sections which accompany it, and here record our sense of personal obligation to Mr. Edwin Walters, of Greenwood county, whose careful surveys with instruments of precision formed the starting-point of the writer's observations; also, for valuable aid, to the Hon. C. J. Butin, of Fredonia.



a, Neodesha Sandstone. *b*, Alluvium and Gravel. *c*, the Yellow Marl.
d, Limestone. *e*, Shale with Coal Seam. *f*, Blue Shale. *g*, Shale.

THE RELATION OF A STATE GEOLOGICAL SURVEY TO THE WORK OF THE NATIONAL SURVEY.

BY A. H. THOMPSON, TOPEKA.

In view of the facts that the United States Topographical and Geological Survey has extended its work to include the entire national domain, and that its scientific operations are much better executed than can ever be accomplished by any State organization alone, it was deemed advisable by some of the members of the Academy that some correspondence should be had with the directors of the national survey, with a view of ascertaining what we should best do to work in concert with them. By coöperation we could, it was thought, accomplish more and better work than by working independently, and we could assist the general survey by the contribution of observations we have already made.

So the writer, acting independently, wrote to Major J. W. Powell, Director of the United States Geological Survey, to ascertain what we had best do to secure the best work for our State. It was explained that we had been hammering away at the matter of getting a bill passed by the Legislature for a State Geological Survey for some years; that the people were in need of such a scientific work, that our resources might be developed, and the wasteful expenditure of capital in the blind search for minerals be avoided; that there was great interest in the matter, as manifested by the numerous schemes which have been before the Legislature for the purpose, but that we had been unable to accomplish anything as yet. But now, in view of the fact that the United States Geological Society intended to cover the entire national domain, and the topographical survey having been already begun in Kansas, that we, the Kansas Academy of Science, desired to know what we should do in order to coöperate with the Government work, that we might get the most benefit out of it for the people of the State.

To this communication a courteous reply was received from Major Powell, saying that the topographical survey of Kansas was progressing satisfactorily, six sheets of the atlas being in the hands of the engraver, and six more were ready for him. Kansas will thus have an accurate map. No geological work can be done without the topographic basis, and how soon this will follow he did not say. He will take pleasure in coöperating with the scientific men of the State in making a thorough geological survey. With the letter he also sent the volume, "On the Organization of the Scientific Work of the General Government," which is the testimony given by Major Powell before a Congressional commission in December, 1884, on the subject. This report is a perfect mine of information upon the much-mixed subject of the United States surveys in particular and of Government scientific work in general. To that volume I am indebted for such facts as are herewith submitted.

In the first place, be it understood once for all, the United States Geological Survey is not intended to take the place of State surveys, nor to do the work demanded of them by the interests of the people. While the topographical and geological work is thorough and elaborate, neither one is of sufficient minuteness to answer the local purpose for which such maps are used. But this survey should be followed and amplified by State work, which should proceed further and give more details upon enlarged maps. Some States—Pennsylvania, New Jersey, and Massachusetts, for instance—have made additional appropriations for the use of the United States Geological Survey, that that organization might make the maps on a large scale, and thereby give greater detail. The people of these States now have maps as accurate as the latest science can make them, and as elaborate as they will require for all purposes. The survey work is, of course, much better done than any State could afford

to do alone. The Director of the National Survey used all the available scientific material of these States to the best advantage; where the work already done is sufficiently good, it is used as a basis, and where in error it is corrected. As all topographic work heretofore done is in error, owing to the inaccuracy of old methods, all that needs to be entirely new work. Some of the geological work is good, but, being wrongly located, must be revised. So that it is to the advantage of the States in every way to have the work done by the national organization, as being better than they can do themselves.

After the work of the Government corps in the West, it was found that with their methods they could do more work for less money, than the State surveys of the East working by the old methods. So the Government survey was invited to work in the Eastern States, some of which had their entire maps made for them by the Government corps of trained observers and calculators. Pennsylvania has had the topographic work done by the Government survey, and will pay the expense of additional detail. Massachusetts began, years ago, to make a topographical survey, and has turned over all the material to the United States Geological Survey, for its working basis. This material is known as the "Borden triangulations." The Legislature appropriated $40,000 for the use of the survey in giving them greater details on maps of larger scale.

The Government work had been begun in Massachusetts — just as it has been begun in Kansas — and the opportunity was seized to secure to the State the best possible map. Maine had a preliminary examination of her rocks made — much as Kansas has had — but made no survey nor maps. New York has had a partial triangulation made by State authority, but the geological survey has not constructed maps. In California a thorough topographical survey was made by Prof. Whitney, and the geological work followed upon that of course, because a topographical survey must precede the geological as a necessary preliminary. Much of the Government work in that State was done on that survey as a first basis.

Grand triangulations upon which the geodetic surveys of the States must rest, should be executed by the General Government, for interstate geodesy will depend for accurate basis and for uniformity and harmony upon the Government survey, which will cover a continent. All State, county, township and other boundaries should rest upon the national system for permanence, as well as the boundaries of estates, and the titles to property. Boundaries do not always appear in nature, but should be defined by unchangeable mathematics, based on the astronomical meridians.

The General Government requires accurate maps for its own purposes — military, political, fiscal, postal routes, etc., and they are necessary to legislation on a variety of subjects; the distribution of mineral wealth, forests, arable and desert lands, the relation of flood districts, drainage, areas, railroads and highways, etc. To these practical subjects must be added the use of maps to that large body of scientific men in every country, on whom the progress of that country depends, to whom accurate maps are indispensable.

It is part of the grand scheme of the national surveys that they shall be supplemented in all the States in which they work, by State surveys, to carry forward this work in greater detail. In fact, all Government work is of this nature. That is, it furnishes the exact scientific basis, and from that the States and individuals can elaborate the minutiæ. And it is right that this should be so; for the general surveys cannot be burdened with the details of the various districts whose different requirements are infinite. This is also the theory of the Meteorological office and the Fish Commission, which furnish bases and material to be elaborated by workers in the details in all the States.

The economic part of geological surveying is a department which cannot for many reasons be done by a national organization; that must be done by the State surveys, and the mineral beds, etc., be properly located and described. Information relating to economic deposits must be furnished by the State surveys when demanded by the people. The general survey makes topographic maps, places on them the geologic formations, and discusses the relations of the iron, copper, coal, phosphates, etc., to the formations. Then the State survey comes in and fixes the values of the deposits, methods of development, and other questions of economic interest; upon this basis many States are reorganizing their surveys.

The surveying and map-making operations of the United States Government are divided into three departments, as follows:

I. The geodetic or coast survey.

II. The geological survey—including, as a necessary preliminary, the topographical work. And

III. The land surveys of the General Land Office.

1. The geodetic or coast survey does that surveying and platting of the coast and adjoining ocean which is necessary to make charts for the use of marines. This work has been carried on for a number of years, and the two coasts of our country are nearly completely charted. That is, the land and coast maps are nearly finished, but there is a continual need of the study of the ocean — the hydrographic work.

2. The geological survey has been referred to, and its work is familiar to every one. Its importance may be noted in the fact that the mineral products of the United States amount to $450,000,000 annually. Surely there should be a scientific basis for this industry, and the topographic work is also important, in that it gives us accurate maps which are of use for many purposes.

Both geodetic and topographic surveying are first begun by the measuring of base lines. These base lines are scattered about 200 miles apart throughout the country, depending on favorable sites. They are four or five miles in length, and are measured many times, to secure the greatest possible accuracy, astronomic and telegraphic methods being used to obtain the latitude and longitude exactly. From these base lines the triangulation is expanded, the first triangles being small, those more remote much larger, the sides sometimes measuring thirty to fifty miles. The intervening country is then triangulated, to locate all objects desired to be noted on the map, and the extent of the measuring and the scale of the map determine the details of the work. The main difference between a geodetic and topographic survey is in the fact that the former is by far the most minute and exact, being primarily made for the purpose of ascertaining the shape of the surface of the earth. For this its methods are very much more refined than the topographic methods, which are intended for map-making only, which is a very different thing. There is no need, in the latter, of determining the location of a point within less than ten feet in 1,000, for such error would not show on an ordinary map. But in geodesy the error must not be one-tenth of that, for, by multiplying, it would become very serious. Geodesy is valuable also in cadastral surveying, or the bounding of private estates and properties, in that it provides unchangeable astronomical data.

The base line from which the triangulation of Kansas is now being carried on is located in southwest Missouri, and the adjoining three States. This is one of the five great base lines the geological survey has located on the national domain, and it would seem to become us to seize the opportunity, while the survey is working within our borders, to have the map made on a large scale, as other States have done, by paying an additional amount for the extra expense of placing minute features on the map. The United States survey, of course, locates all streams and all eleva-

tions, timber, etc., and the permanent cultural features, such as towns, railroads, etc.; but the less permanent cultural features, the minute natural features, the lesser boundaries, etc., it does not locate. The general geology is given on the maps, but not the minutiæ which are necessary for economic purposes. These extra details the State should secure by paying for the additional expense of making maps of a larger scale, and it should be done by prompt action on the part of the Legislature.

It is interesting to note the exactness of the Government survey work, in that the average error of the geodetic work of the coast survey is not over one-half inch per mile, and the average error of the topographic work of the geological survey is not over six inches per mile; that is, in a line of twenty miles the error would be ten feet. That is the height of human accuracy, for such error cannot appear on any ordinary map, even of the larger scale.

The maps in the far West were constructed by the geological survey on a scale of four miles to the inch. But in the Eastern States in conjunction with the coast surveys, the scale is one mile to the inch, which shows all the minute natural and cultured features required. Such a map costs $10 per square mile to survey, one-half being borne by the General Government, and one-half by the State. Such a map the State of Kansas needs and can easily afford for the benefits acquired. Extra minuteness in the geology will of course cost something additional besides, but only a trifle to this great State with such wonderful mineral resources. There is now enough capital being thrown away in any one year in the blind search for coal, iron, zinc and other minerals to pay for a good geological survey in connection with the national work. Why, the city of Topeka has voted $15,000 for the purpose of boring a shaft to ascertain if a paying vein of coal does not underlie the city somewhere in the bowels of the earth. The experimental boring is to be made on the principle that the coal is sure to be found, if the money holds out to go deep enough. But the geologist knows that there are many factors to be considered in such an experiment, which only an exact and comprehensive survey can furnish. So capital is being wasted everywhere in the State.

3. The surveys of the General Land Office are made by chart and compass, without the least regard to scientific location. Townships are drawn upon paper and then staked out on the ground, beginning anywhere, and ending when it runs up against another party's survey. It seems amazing that there should have been no astronomic starting-point for these surveys, but such is the fact. They should have been founded as the cadastral surveys of other civilized countries are based — upon geodetic surveys; but it was not so done, and cannot now be remedied. Trouble has already arisen in regard to boundaries in many of the Eastern States, and much more difficulty and litigation will follow. The land surveying is performed by contract by private surveyors, being let to the lowest bidder. Anyone can readily appreciate what sort of work that would result in. The surveying was done by a party staking off a north-and-south meridian anywhere, and measuring off the mile-square sections from that. Where the plat of one party joined that of the next, fractions were introduced to fill up the space. But fractions also occur elsewhere, owing to errors necessarily made by the crude methods of measurement. But even if accurate and well done, it would be impossible to secure permanent boundaries, so necessary for deciding disputes, for the starting meridians are located without any reference whatever to the meridians of longitude, astronomically located at regular intervals and readily determined. So that if the accidental meridian of the land survey is lost, by the destruction of the stakes or corner-stones, it cannot be found again. If the land survey had been properly founded on a scientific survey, boundaries could be readily found and titles of all kinds of property in the West would be more secure. The coast survey, where it has mapped the coast and a narrow strip of adjoining land,

has made cadastral or estate survey on a minute scale, with all the exactness of geodesy. If the country of the West had been triangulated, even grossly, and the land survey made upon that basis, its work would have been much more reliable and permanent. The topographic and even the geodetic surveys of France and England preceded the cadastral, or estate, surveys of that country, so that all boundaries are exact, and all features permanently located. These maps need to be changed only as the cultural features change.

There is in Europe an international geodetic system which is uniform and mutually dependent. In this country there should be such an interstate system, and this we have in the topographic and geological survey of the General Government. Upon this or an accurate scientific basis it is intended that the States shall have their surveys, and elaborate the details as much as desired.

In view of these imperfectly presented facts, then, the final consideration is, what should the State of Kansas do to secure the best benefits from the United States survey within her borders? The reply is, briefly, that the Legislature should make an appropriation for the enlargement of the scale of the maps, in order that more details may be shown and the maps be made more generally useful for all scientific and economic purposes. Other States are now doing this, and having the Government survey do the work for them, for the reasons — to briefly recapitulate — that the survey is already organized and equipped, and has the best specialists in its permanent employ, and the work can be done with infinitely greater accuracy than by hastily-organized State surveys with political hindrances, and they can do the work much cheaper for the States than they can do it themselves, and will conduct the work with the uniform system of the whole country. The cost to the State of Kansas for the enlargement of the map would be from $10 to $15 per square mile for all the survey work. Not being mountainous, the expenses would be light, and the progress more rapid. Already the eastern third of the State is surveyed by the topographical corps on the Government scale of four miles to the inch, and if we wait until the entire State is covered the cost of resurveying for the large scale of one mile to the inch will be much greater. The smaller scale is all needed to base boundary surveys upon, which will in time save much trouble.

The State work of the national survey should be managed by a commission of scientific men, who would have cognizance and control of the work which the Director of the United States would execute for them. Such a commission as the President of the Kansas Academy of Science, the Secretary of the State Board of Agriculture, and the Superintendent of Mines, would be appropriate and capable.

The Academy should appoint a committee to take the matter under advisement, to correspond with the Directors of the United States Geological Survey as to methods of procedure for coöperation, and get it into shape to present to the Legislature. The Academy should further memorialize the Legislature to act promptly in the matter, for the workmen are upon our ground, and the opportunity is passing.

ON THE DESTRUCTION OF THE PASSIVITY OF IRON IN NITRIC ACID BY MAGNETIZATION.

BY EDWARD L. NICHOLS AND W. S. FRANKLIN,
Of the University of Kansas.

I.

During the winter of 1884–5, the authors of this paper were engaged in the investigation of chemical behavior of iron in the magnetic field. In the course of their experiments they had occasion to bring into the field of a small electro-magnet, a beaker containing powdered iron submerged in cold concentrated nitric acid,

the iron being in the passive state. While in the magnetic field the iron was touched with the bulb of a thermometer used in the determination of the temperature of the solution. Thereupon it lost its passivity, and the solution burst into violent effervescence. The reaction continued until the beaker was removed from the field, when the iron again became passive. Investigation showed that this change of condition was due to the action of the magnet, occurring instantly in solutions of high temperature or of small degrees of concentration, and taking place upon stirring within the field, even in the case of iron in cold concentrated acid. Mention of this fact has been made in the published account of the above-mentioned experiments.[1]

The further study of the phenomenon forms the subject of the present paper.

The influence of the electric current upon the passivity of iron has been known for half a century; Schönbein having described it in a letter to Faraday, in which the discovery of the passive state was first announced, as follows:

" . . . I was very curious to know in what manner iron would be acted upon by nitric acid when used as an electrode. For this purpose I made use of that form of the pile known as the *couronne des tasses*, consisting of fifteen pairs of zinc and copper. A platina wire was connected with (what we call) the negative pole of the pile, an iron wire with the positive pole. The free end of the platina wire was first plunged into nitric acid, sp. gr. 1.35, and by the free end of the iron wire the circuit closed. Under these circumstances the iron was not in the least affected by the acid; and it remained indifferent to the fluid not only as long as the current was passing through it, but even after it had ceased to perform the function of a positive electrode. The iron wire proved, in fact, to be possessed of all the properties of what we have called a passive one. If such a wire is made to touch the negative electrode, it instantly becomes active, and a nitrate of iron is formed; whether separate from the positive pole or still connected with it, and whether the acid be weak or strong." [2]

Faraday[3], as is well known, followed up Schönbein's work with a variety of ingenious experiments of his own, and reached the conclusion that the passive state is due to the formation of an insoluble film of oxide upon the metal, and that the power of the electric current to produce passivity in iron which acts as a positive electrode, lies in the liberation of free oxygen at the surface of the metal. If Faraday's theory needed other confirmation than that afforded by his own varied experiments and those of Schönbein, it has received support from the work of Boutmy and Chateau[4] who pointed out the power of chromic, sulphuric and permanganic acids to promote passivity, and from the more recent researches of Renard[5], in which it was shown that reducing agents have a tendency to destroy the passivity of iron, while oxydizing agents tend to bring about the passive state.

II.

The behavior of iron in nitric acid solutions varies in the most striking manner with the temperature and strength of solution, and with the molecular condition of the metal. The active metal may be dissolved with evolution of nitrous fumes and the production of a ferric salt, with the evolution of hydrogen and the formation of a ferrous salt, or without the evolution of any gas; the character of the reaction depending upon strength of acid and temperature.[6] In anticipation of similar variations in the transition from the passive to the active state, it was thought best before undertaking the study of the influence of magnetism upon passivity, to make the following preliminary experiments.

1.—*On the behavior of passive iron in cold nitric acid.*

One gram of iron was placed in 8 cc. of nitric acid (1.368) and allowed to stand.

[1] On the Chemical Behavior of Iron in the Magnetic Field: Am. Jour. Sci., vol. 31, April, 1886.
[2] Experimental Researches of Faraday. Vol. II, p. 237; also Philosophical Magazine, May, 1836.
[3] Faraday; Experimental Researches. Vol. II, p. 244.
[4] Boutmy and Chateau; Cosmos, XIX, p. 117.
[5] Renard; Comptes Rendus. Vol. 79, No. 5.
[6] Ordway; American Journal of Science. II Vol. XL, p. 316.

The metal was apparently perfectly passive, and maintained that appearance throughout the experiment. The temperature of the solution was 20° C. Upon standing, the acid began to show signs that the passivity was not complete, at the end of an hour the amount of iron in solution being sufficient to color the acid unmistakably. Repetitions of the experiment always with the same result led to the conclusion that at least in the case of finely-divided "iron by alcohol" in strong acid, Ordway's third reaction (the solution of the iron without the evolution of gas) was always going on.

2.—*On the destruction of passivity by heat.*

A test-tube containing passive iron in the strong nitric acid was placed in a water bath, and gradually heated. Rise of temperature was found to increase the rapidity of the reaction without evolution of gas. This reaction was gradually supplanted by the second reaction described by Ordway—with elimination of hydrogen—effervescence becoming very evident at 60° C. Under these conditions the metal certainly could not be considered as "passive" in the strict sense of the word, and yet the reaction differed entirely from that of strong acid upon active iron. At this temperature the concentrated acid acts upon "passive" iron in a way similar to that in which very dilute acid attacks the active metal. The transition between these two reactions was not sharply marked. Further heating increased the effervescence, until within the neighborhood of 80° nitrous fumes began to be evolved. The reaction was still far from reaching that which such acid is capable of exerting upon active iron, but the condition of the solution became more and more unstable, and a slight rise of temperature sufficed to render the iron subject to the full effect of the acid. This final and complete loss of passivity was very sharply marked by the beginning of a reaction of fairly explosive violence. Repetitions of this experiment showed that the temperature at which these successive changes occur depends upon a variety of circumstances. It was found to vary with the time the iron had been exposed to the acid, the strength of the acid, and the character of the iron. Even the presence of small quantities of the salts of iron produced by these reactions was found to influence in a marked degree the temperature at which in a subsequent trial the metal became active.

3.—*The influence of time.*

The influence of the time of exposure upon the temperature of loss of passivity was first noticed during the experiments just described. A test-tube containing passive iron in nitric acid had been allowed to stand for some time before being placed in the water bath. Instead of retaining its passivity to a temperature of nearly 90°, this specimen became active at a much lower temperature. Repeated trials showed that continued exposure always lowered the temperature of loss of passivity. For the purpose of determining the extent of this variation, other conditions were kept as nearly uniform as possible, and the iron was exposed for different intervals of time to the acid before the destruction of passivity. The control of conditions but imperfectly understood was exceedingly difficult, and the results showed irregularities which would doubtless disappear were the time the only source of variation. The series given in the following table is thought, however, to indicate with a fair degree of accuracy the influence of the time of exposure upon the temperature of loss of passivity. The time given in the table is that which elapsed between placing the iron in the acid and its change to the active condition. It will be seen that the temperature of transition diminishes as the time of exposure increases.

TABLE, showing influence of the duration of exposure to the acid upon the temperature at which iron becomes active in HNO_3; sp. gr. 1.368.

Number.	Duration of exposure.	Temperature of transition.	Number.	Duration of exposure.	Temperature of transition.
		Deg. C.			Deg. C.
1	0m., 45s.	89.4	5	9m., 30s.	78.3
2	1m., 2s.	84.2	6	13m., 50s.	71.5
3	4m., 25s.	79.3	7	25m., 30s.	70.8
4	6m., 25s.	78.7			

4. *On the influence of the presence of Iron-salts in the solution.*

The presence of even a small amount of the final products of the action of nitric acid upon iron was found to lower the temperature of transition to the active state to a marked extent. In order to obtain consistent results, it was necessary to clean the test-tubes in which the reaction was to take place, and the thermometer, by boiling in sulphuric acid. The failure to thoroughly cleanse the latter repeatedly reduced the temperature many degrees (in one instance to 60°), and in a test-tube from which the products of a former reaction had not been entirely removed, it was often impossible to render iron passive, even at 20°.

5. *On the influence of the strength of acid.*

A much more obvious cause of variation in the temperature of transition than those already alluded to, lies in the different strengths of acid in which the iron is submerged. A set of experiments upon this variation gave the following results:

TABLE, showing temperature of transition from the passive to the active state in acid of different degrees of concentration.

Sp. gr. of acid	1.368	Temperature of transition	89.5°
" "	1.354	" "	82.3
" "	1.306	" "	69.6
" "	1.130	" "	23

The time of exposure to the acid was in each case about 40 seconds. This determination agrees well with that noted by Schönbein for iron wire in nitric acid of sp. gr. 1.35. He found the change to occur at 75°.

III.

In all these experiments, the method pursued had been very simple. The powdered iron was placed in the bottom of a perfectly clean and dry test-tube, and the acid, having been measured out into a beaker, was poured upon it. The test-tube was placed in the water-bath, a thermometer was inserted in the acid, and the transition temperature, always indicated by an explosion of such violence as to expel the greater portion of the contents from the tube, was noted. In order to protect the observer from the explosion, an inverted glass funnel was set over the whole, part of the thermometer projecting beyond the tube of the funnel. Figure 1 shows the arrangement of this apparatus.

In carrying on similar experiments in the field of an electro-magnet, the complete protection of the instrument from the acid fumes generated by the reaction, was necessary. This was accomplished by the apparatus shown in figure 2, in which all the fumes generated were carried away. The test-tube holding the iron and acid for the reaction was placed in a slightly larger tube between the pole pieces of a large electro-magnet. Into the mouth of the larger tube was fitted a thermometer by means of a rubber cork; a long and narrow tube inserted just below the mouth of this outer tube, afforded an exit for the gaseous products of the reaction. The escaping gases were caught over a pneumatic trough.

The electro-magnet was a large one, designed with special reference to this work. The diameter of each of the cores was 55 mm. and their length 380 mm. The pole pieces of this magnet were so fashioned that the tube containing the iron and acid could be brought into a field of high intensity, (about 20,000 H.)

FIG. 1.

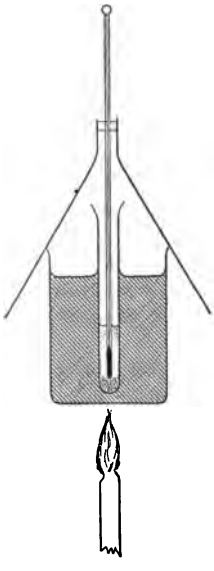
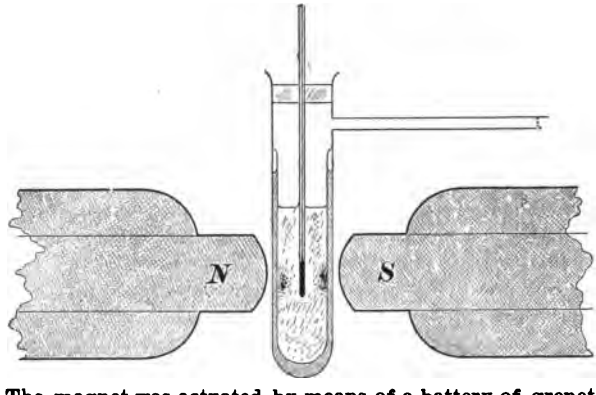


FIG. 2.



The magnet was actuated by means of a battery of grenet cells, and a rheostat of simple construction made it possible to reduce the strength of current at will. This instrument consisted of a fine platinum wire, .03 mm. diameter and 65 cm. long, which was stretched in a glass tube of 5 mm. diameter. To the lower end of the glass tube was fastened one of soft india-rubber, rather more than a meter in length, to the free end of which a glass funnel was attached. The glass tube having been fastened vertically to an iron standard, and the funnel being supported in an adjustable ring attached to the latter, the funnel was filled with mercury, which thus entered the glass tube containing the platinum wire. By raising and lowering the funnel, this mercury column could be made to occupy any desired portion of the tube. That part of the platinum wire not immersed in mercury, constituted the resistance wire of the rheostat, and this resistance could be given any desired value up to that offered by the entire wire. To prevent the heating of the resistance wire, the tube above the mercury was filled with distilled water, the top of the tube being enlarged to receive the water when expelled by the rising mercury. This rheostat is shown in figure 3.

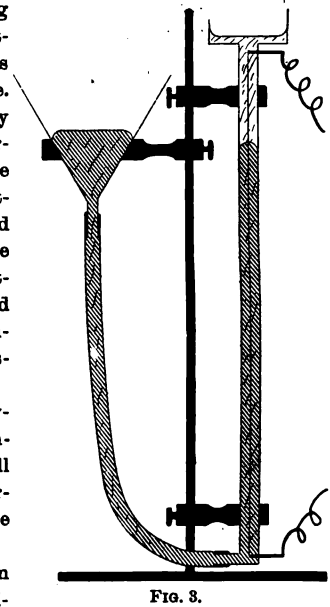


FIG. 3.

The strength of field was estimated by observing the swing of a delicately suspended galvanometer needle induced by the withdrawal of a small coil of known area from the field, and by comparing this deflection with that produced upon the same needle by a Weber's "earth inductor."

With this apparatus the influence of magnetism upon the passivity of iron was studied under various circumstances and conditions. It was found very difficult, even with the knowl-

edge of the causes of the variation in the temperature of transition gained from the preliminary experiments, to obtain entirely concordant results, but we succeeded nevertheless in establishing a number of interesting facts concerning the action of the magnet. The following paragraphs descriptive of the more interesting results obtained with the magnet are taken directly from the rough notes made while the investigation was in progress.

(*a*) 8cc. HNO_3 sp. gr. 1.368 acting upon 1 grain of iron in the magnetic field. The tube containing the iron and acid was immersed in water which up to the beginning of the experiment had been boiling, but from which the flame had just been removed. The strength of the field, which was insufficient to destroy passivity at the temperature of the room (20°), was not measured. Effervescence began at once, and increased until the thermometer indicated 51°, when the explosion characteristic of the loss of passivity occurred, blowing most of the liquid from the tube. The remainder became quiescent again, but when touched with the thermometer bulb its explosive activity returned. The reaction differed apparently in its nature from that taking place out of the field. The products of the reaction, when poured from the tube, left the tube and the thermometer bulb clean, whereas after the ordinary reaction they were thickly coated with a black residue which could not be washed off and the complete removal of which necessitated long boiling in acid.

(*b*) A repetition of experiment (*a*), with the magnet not acting. The thermometer rose steadily to 89°, when the transition to the active state took place.

(*c*) Conditions those of experiment (*a*). Temperature of transition again 51°. We noticed that passivity was not lost throughout the mass of iron at once, but began at a single point on the side of the tube, whence streams of gas were evolved, while the rest of the iron remained passive.

From this as a center the action spread until the entire mass became involved. The temperature noted was that at which activity had become general.

(*d*) Conditions those of experiment (*a*), excepting that the magnet was inactive until the temperature of the solution reached 60°, when the circuit was closed. Passivity was destroyed at once.

(*e*) Conditions those of experiment (*a*), excepting that the circuit was made and broken at every degree from 40° upward by tapping a key. But little effect could be noticed until in the neighborhood of 60°. Each tap was followed by momentary effervescence and by a sudden rise of the thermometer, which were more and more marked as the solution became hotter. Complete and permanent activity, such, namely, as was capable of maintaining itself without the continued action of the magnet, did not occur until a temperature of 87.5° was reached.

(*f*) A repetition of experiment (*a*), but with less current, [.28, as much as indicated by a tangent galvanometer in the circuit.] The magnet was in function throughout the experiment. The transition temperature was 84.5°.

(*g*) The acid and iron were placed in a bath at 20°, and brought into a much stronger field than that employed in experiment (*a*). [Strength of field, estimated by the method described in a former paragraph, was about 20,000 H.] Loss of passivity in this field occurred instantly upon closing the circuit.

(*h*) The acid was diluted with one-half its bulk of water; and the iron having been introduced under the protection of a strip of platinum foil remained passive when the latter was withdrawn. The temperature of the acid was 23°. The iron lost its passivity instantly in a field of very moderate intensity, and regained it only when removed from the neighborhood of the magnet. The very slight residual magnetism of the electro-magnet was found to be sufficient to destroy passivity in this dilute acid, the action recurring violently whenever the tube was brought between the poles

of the magnet, even when the circuit was open. Upon repeating this experiment with somewhat stronger acid we found the strength of field requisite to the destruction of passivity much greater with three parts of acid and one of water; the iron remained passive under the residual magnetism of the magnet, and even in the field produced by the current last employed. When the current was somewhat further increased the iron became active.

The tangent galvanometer when the transition took place, indicated .16 of the current which in experiment (*a*) had been necessary to destroy the passivity in concentrated acid at 51°. And the field was certainly of but little more than half the strength of that under which, in experiment (*f*), iron had maintained its passivity in the stronger acid to 84.5°.

In four parts of acid and one of water, at a temperature of 23.3°, the iron remained passive until the current strength had reached .23 of that used in experiment (*a*).

(*i*) To determine in what strength of acid iron would become active at these temperatures, without the influence of magnetism, or at least in the earth's field, the usual quantity of iron was placed in concentrated acid and the acid rapidly diluted with water and with such small amounts of snow as were necessary to keep the mixture in the neighborhood of 23°. Dilution was continued until the iron had become active. The transition was much less clearly marked than at high temperature or within the magnetic field, but repeated trials showed that the amount of water to be added to 10 parts of acid in order to destroy passivity was about 13.

(*j*) To 20 cc. of concentrated acid at 0° containing passive iron, water was added, with snow in quantities sufficient to prevent any marked rise of temperature. The addition of 172.3 cc. of water and snow did not produce any noticeable reaction. When placed in the field of the electro-magnet [strength about 20,000 H], effervescence began at once, and a dark-green solution of higher density than the acid was formed. The color soon disappeared and a brown precipitate showed itself, which was dark colored and highly magnetic.

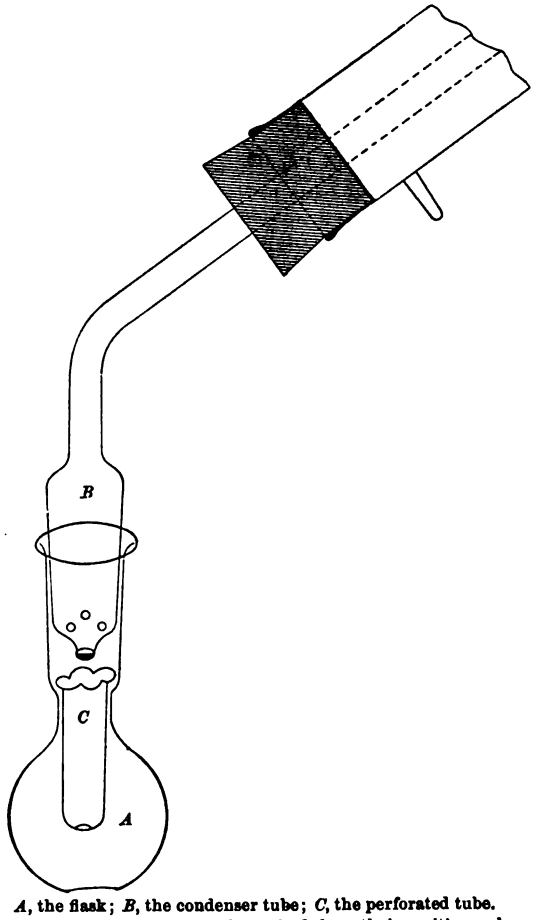
By repetition of the experiment outside of the field, it was found that a trace of color could be detected when the acid had been diluted to $\frac{10}{47}$, (subsequent trials changed this ratio to $\frac{1}{5}$,) and that the first evolution of gas could be noticed when the strength of the acid had been further reduced to $\frac{1}{13}$. Further dilution to $\frac{10}{261}$ produced no further changes, nor did the evolution of gas at any time approach that produced in the magnetic field at this temperature.

It appears from the foregoing experiments, that the action upon the passivity of iron in nitric acid consists in lowering the temperature of transition to the active state, and that the intensity of the magnetic field necessary to convert passive into active iron at a given temperature increases rapidly with the concentration of the acid. The influence of magnetism upon the passivity of iron in other acids must be determined by other experiments. The establishment of a satisfactory theory of the influence of magnetism upon passivity will demand not only a much more complete acquaintance with the phenomena touched upon in this paper, but a wider knowledge than we now possess of the subject of chemical action in the magnetic field.

ON A NEW APPARATUS FOR THE CONTINUOUS EXTRACTION OF SOLIDS BY A VOLATILE SOLVENT.

BY J. T. WILLARD AND G. H. FAILYER.

The authors have devised a new form of extraction apparatus, which is so satisfactory to them that they think a brief description of it may be of interest to other chemists. It consists of three parts: the flask *A*, the condenser *B*, and the perforated tube *C*. The flask is 14–15 cm. in height, and weighs about 45 grams. The upper part of the neck is ground to fit the condenser, and is 3 cm. in diameter. The lower part of the neck contracts suddenly to 2.5 cm. in diameter, thus presenting an annular projection within, which supports the perforated tube. The tube of the condenser is about 75 cm. long, and has an internal diameter of 8 mm. Near the lower end it is bent at an angle of 60°, and passed upward through a copper tube 3–4 cm. in diameter, which is supplied with cold water when in use. The lower end expands into a stopper for the flask, and the extremity is brought nearly to a point to direct the dropping of the condensed solvent. Three additional openings are made in the stopper expansion to allow the vapor free passage upward. The perforated tube is similar to a short, wide test-tube with the bottom perforated. The lip is notched to give openings for the passage of the vapor. The body of the tube must pass readily through the contraction in the neck of the flask, and at the same time the lip must rest securely on the inner projection. The lower end of the tube may reach within 1.5–2 cm. of the bottom of the flask.



A, the flask; *B*, the condenser tube; *C*, the perforated tube. *B* and *C* are shown somewhat raised from their positions when in use.

The mode of using the apparatus is almost obvious. The substance to be treated is confined in the perforated tube between two layers of asbestos, a sufficient amount of the volatile solvent is put into the previously-weighed flask, and the parts are put in place and suitably supported. Upon heating the solvent by means of a water bath the vapor is evolved with any rapidity desired, and passes into the condenser. The condensed solvent flows uninterruptedly down the same tube, drops into the

perforated tube, filters through the substance to be extracted, and passes back into the flask. After the operation has continued as long as is desired, the perforated tube is removed, the apparatus inclined so as to carry the condensed liquid out instead of back, and the solvent distilled off. The solvent may thus be recovered, which is an item of no small importance where ether is used and many determinations are to be made. The flask with the substance extracted is then carefully dried and weighed.

The chief advantages of this extractor are, its simplicity and consequent convenience of handling, and its freedom from corks which come in contact with the solvent. It avoids the slender tubes and multiplicity of connections so common in extractors, and at the same time can be manufactured at a very moderate cost. Every chemist knows the difficulty and inconvenience of completely removing the soluble substances from corks, but if it is desired the flask can be made without having the neck ground, and it can be connected by a cork to an inverted Liebig's condenser. In this form the extractor is still cheaper, and, even with the one cork, is more desirable than any other form that has come under our notice.

This apparatus was designed for quantitative work, but with some modifications it might be adapted to pharmaceutical operations. The flask would have to be made deeper and the neck much wider, to admit a large perforated tube. The flask could be connected with the condenser by means of a broad ring of glass, ground on its outer edge to fit the neck of the flask, and within to fit the condenser tube. In that way an apparatus of considerable capacity could be constructed, and we think at less cost than those now in use.

REPORT ON GEOLOGY.

BY ROBERT HAY,

One of the members of the Geological Commission of the Academy.

The writer does not know of any geological work accomplished in the State during the past year, which is available for this report to the Academy, except that done by himself, most of which will be given in papers on definite subjects. There is one point, however, to which he must definitely refer here, viz., the easterly extension of the Tertiary formations in southern Kansas. In the northern part of the State the eastern limit has been marked by Prof. Mudge and Prof. St. John, with some approach to accuracy, notwithstanding the difficulty of distinguishing them in that region from the yellow marl or other quarternary deposit. In the southern part, however, no map of the State has yet recognized the existence of Tertiary deposits south of the Arkansas river, or as immediately resting on paleozoic formations. The writer has found this year, however, that the formation which in his report on Norton county he called the Equüs Beds (Cope), is the deposit forming the high prairie in the counties of Hamilton, Finney, Seward, Ford, Edwards, Pratt, Comanche, Barber, Kingman, and Sedgwick. In the latter county he found it east of the sixth principal meridian, east of the Arkansas river, a few miles out of Wichita, and there it was in contact with the Permian strata of the region.

In many places this formation, which in our note-books we uniformly designate as tertiary marl, lies over the same deposit which in the northwest we have called the Loup Fork. It contains the same fossils, mammalian bones, and turtle; and has the same variety of structure, from a mortar-like grit to a heavy conglomerate. In several places, however, it was manifest that the mortar-like grit is the upper part of the deposit, the conglomerate being below. We found the conglomerate beneath the

tertiary marl in places very wide apart; *e. g.*, west of Garden City, on the Cimarron river, in Meade county, in Comanche and Barber; and we are inclined to think an isolated patch near Wellington, in Sumner county, also belongs to it. This being so, the future maps must recognize the tertiary formations in the south as far east as the sixth principal meridian. As we show elsewhere, this fact is of economic value as bearing on the water supply of the west. In one place the tertiary grit yielded abundance of a pretty fossil univalve.

In the wild region stretching west from Medicine Lodge into Comanche county another problem has to be worked out, viz., whether the red rock and the gypsum belong to Cretaceous or older formations, Triassic or Permian. The beautifully variegated sandstones referred to by Professor Cragin in a printed notice of a run through Barber county I am inclined to consider as undoubtedly Dacotah, but in the only place where I got at their base they seemed to rest on the eroded surface of the Red Rock. On the other hand, in the west part of Sumner county we found a red clay intercalated with the well-known Permian strata. This clay was so like the clay of the Red Rock series that it seems to be a premonition of it. The line of contact of the undoubted Permian and the Red Rock series runs through Harper and Kingman counties. That line calls for investigation.

There are many matters of interest that will be dwelt upon by investigators of the southwest: caves in the gypsum, the habits and habitats of animals, great fossil remains; but one of the greatest wonders to be made known will be the story of EROSION, which a geologist able to read his record will have to transcribe and illustrate so that others may understand how hills and mountains are carved out of the dead level of the prairies, and how the hardest rocks marked by the stylus of the ages are read like rolls of ancient seers.

ON THE OCCURRENCE OF BROMIDES AND IODIDES IN THE WATER OF AN ARTESIAN WELL AT INDEPENDENCE, KAS.

BY PROF. E. H. S. BAILEY, LAWRENCE, KAS.

Some time since, in boring for coal, a well 1,091 feet in depth was sunk at Independence, Kas. The well proved to be of value in furnishing a strong mineral water. This brine has a specific gravity of 1.052, and issues at a temperature of 62° F. The well is piped for 400 feet, and the water is pumped from a depth of about 300 feet.

On analysis the water was shown to contain the following constituents, expressed in grammes per liter:

Constituents.	*Grammes.*	*Constituents.*	*Grammes.*
Silica ($S.O_2$)	0.0198	Bromine (Br)	0.1826
Iron Peroxide (Fe_2O_3)	0.0106	Iodine (I)	0.0013
Alumina (Al_2O_3)	a trace.	Carbon Dioxide (CO_2)	0.2679
Calcium Oxide (CaO)	3.8710	Organic matter	a trace.
Magnesium Oxide (MgO)	2.5400		
Potassium Oxide (K_2O)	0.1277	Total	83.4071
Sulphuric Oxide (SO_3)	0.1997	Less Oxygen equivalent Cl. Br. I.	10.1967
Sodium Oxide (Na_2O)	31.0563		
Chlorine (Cl)	45.1302		73.2104

These substances are probably combined in the following manner. The values are expressed in grains per U. S. gallon of 231 cu. in.:

Substances.	*Grains.*	*Substances.*	*Grains.*
Sodium Chloride	3,466.921	Calcic Bicarbonate	30.537
Magnesium Chloride	347.770	Ferric Bicarbonate	1.682
Calcium Chloride	419.140	Silica	1.155
Sodium Bromide	13.711	Alumina	a trace.
Sodium Iodide	0.092	Organic matter	a trace.
Potassic Sulphate	13.771		
Calcic Sulphate	9.047	Total solids	4,303.826

It will be noticed that this water is especially rich in magnesium chloride as well as salt, and suggests ocean water in its composition, though it is of about twice the strength of the latter. The water contains also comparatively large quantities of Bromides and of Iodides, substances thus far rare in the waters of Kansas. For purposes of comparison the analyses of some celebrated waters are here inserted, with the amounts expressed in grains per gallon:

Substances.	*Artesian well, Franklin, N. Y.*	*Hathorn Spring, Saratoga.*	*Congress Spring, Saratoga.*	*Dead Sea.*
Sodium Bromide	4.655	1.534	8.559	156.53
Sodium Iodide	0.235	0.198	0.138	a trace.

The Atlantic ocean contains 31.16 grains of Sodium Bromide per gallon, and a decided trace of Iodide. The Independence water is utilized to some extent locally for bathing purposes.

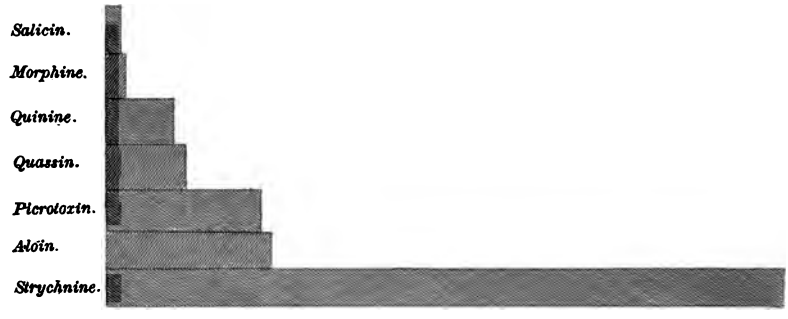
THE RELATIVE BITTERNESS OF DIFFERENT BITTER SUBSTANCES.

BY E. H. S. BAILEY AND E. C. FRANKLIN.

The method of investigation followed was similar to that reported at the last meeting of the Academy, in an article upon the "Delicacy of the Sense of Smell," and also in a paper presented to the American Association for the Advancement of Science, Phila. (1884), by one of us (Bailey), and Dr. E. L. Nichols. Briefly, the method was as follows: We made use of Salicin, Morphine, Quinine, Quassin, Picrotoxin, Aloin, and Strychnine. A series of solutions in water of each of these was prepared, such that each member was of one-half the strength of the preceding one. This series was extended till it was impossible to detect any bitter taste in the last solution. The order of the bottles containing the solution was completely disarranged, and the test consisted in an attempt to pick out, by tasting of a few drops of the contents of each bottle, those which contained a bitter substance. Some bottles containing pure water were included in the above set by way of comparison. This set of solutions was tasted by forty persons, including some of both sexes. We noted in each case how far down in the series it was possible for a person to go. The *average* amount detected is as follows:

Of Salicin it is possible to detect one part in	12,000	parts of	water.
Morphine " " "	14,000	"	"
Quinine " " "	76,000	"	"
Quassin " " "	90,000	"	"
Picrotoxin " " "	197,000	"	"
Aloin " " "	210,000	"	"
Strychnine " " "	826,000	"	"

This relative bitterness is best illustrated by the diagram:



AVERAGE OF FORTY OBSERVATIONS.

A comparison of authorities will show that there is a wide difference of opinion as to the amount of some of those substances that can be detected by the sense of taste. Some state that one part of strychnine in 30,000 parts of water can be detected, while others place the figures at one part in 700,000. The above experiments show that the latter is nearer the truth.

Twelve of the experimenters were able to detect one part of strychnine in 1,280,000 parts of water; or if one cubic centimeter be considered as sufficient for a taste, they were able to detect $\frac{1}{1700}$ of a grain. Several who had taken large quantities of quinine were able to detect relatively small quantities of this substance.

The fact that has been previously noticed by chemists, that solutions of aloin lose their strength on standing, was confirmed. The curious anomaly was apparent, that while some could taste solutions of aloin as dilute as those of strychnine, others could not detect any bitterness in a solution which contained one part of aloin in 1,250 parts of water. We were able to detect chemically, by concentration, the strychnine in $\frac{1}{10}$ of a cubic centimeter of a solution that contained less than one part in one million parts of water. So it would seem that a chemical test is about equal to the *average* delicacy of the sense of taste for this substance. In the case of any particular individual, however, the chemical test is liable to be more delicate. It is not necessary to say that the latter is more *reliable*, for it not only detects a bitter substance, but tells what particular principle is present. We have found that sulphuric acid and potassic bichromate gave the most delicate results. It is our intention to continue these experiments, and, by having tests made by a much larger number of persons, to more thoroughly substantiate our results.

ON THE SWEETNESS OF INVERT SUGAR, WITH SOME NOTES ON ITS PREPARATION.

BY J. T. WILLARD, MANHATTAN, KAS.

A solution of cane sugar possesses the power of rotating a ray of polarized light to the right. If this solution be treated for a few minutes with a dilute mineral acid, it is changed so that it becomes levorotary. Hence it is said to be inverted, and the product is called invert sugar. It is produced, though not so rapidly, by the action of organic acids on cane sugar. When fruit is cooked with sugar, much of the sugar is inverted. A determination of the relative sweetness of the two sugars thus assumes a practical aspect.

Invert sugar is usually said to be a mixture of equal equivalents of dextrose and

levulose, although recent work seems to show that the ratio between the two varies somewhat with the conditions of preparation. Levulose is said to be slightly sweeter than cane sugar. Dextrose, according to Parmentier, is five-sixths as sweet as cane sugar. If these estimates be true, we should expect invert sugar to be somewhat less sweet than cane sugar. According to the statement of Tucker, (Manual of Sugar Analysis, page 89,) invert sugar is of rather sweeter taste than cane sugar, and Prof. Henry Morton places the excess at ten per cent. (Ibid, p. 10.)

The determination of the sweetness of invert sugar is beset with many difficulties. As it is an uncrystallizable syrup, it cannot be obtained pure by crystallization from its solution. The methods of preparing it given by authorities, are two, viz.: by inversion of cane sugar by heating with sulphuric acid, and afterward removing the acid by means of barium carbonate, or by heating with hydrochloric acid and removing the acid with silver oxide. Solutions of invert sugar prepared by the former method invariably possess a slightly earthy taste, while those prepared by the second method have a disagreeable, metallic taste, due to solution of a small amount of silver oxide. It was suspected that the earthy taste of solutions prepared by the first method was due to barium carbonate. Upon adding a little clear solution of calcium sulphate a considerable amount of barium sulphate was precipitated, and by filtering again a solution was obtained which, though not absolutely free from foreign taste, was much superior to that prepared by the unmodified method. Another difficulty to be met in preparing this substance is the fact that if the acid be allowed to act too long the sugar is changed still further into humus compounds, and if it is not allowed to act long enough the sugar is not all inverted It was found that 40 g. of sugar in 200 cc. of water were completely inverted in twenty minutes by 3 cc. of concentrated sulphuric acid, without coloring the solution. The temperature was maintained at 75° C. during the whole time. A shorter time may be sufficient, as the minimum period was not determined.

Invert sugar prepared in the manner described was made into solutions of various strength. These solutions were compared with similar solutions of cane sugar. They were submitted to a number of persons, whose opinions as to the relative sweetness of the solutions varied somewhat. Upon the whole, the invert sugar seemed to be about five-sixths as sweet as cane sugar.

Experiments were also made by cooking a definite weight of Winesap apples with sugar, and comparing the product with that obtained by cooking the same amount of apples and sweetening after the cooking was nearly completed. All precautions were taken to make the experiments strictly comparable. These samples were submitted to various persons, and their opinions as to which was the sweeter were evenly divided. This shows conclusively that for all practical purposes fruit may as well be sweetened before cooking as afterward. Analysis showed that in the sample in which the sugar was cooked with the apples, a large proportion of it was inverted. The cooking was purposely continued much longer than necessary, in order to give opportunity for inversion to take place.

In my efforts to prepare invert sugar free from foreign taste acquired during its preparation, attempts were made to invert cane sugar in solution by saturating with carbon dioxide. Lippman states that such solutions are entirely inverted in one hundred and fifty hours; but, although the solutions in my experiments were saturated with the gas and a slow and continuous current was maintained for eleven days, only a trifling amount of inversion took place.

OBSERVATION OF THE FORMATION OF SUGAR CRYSTALS IN THE JUICE OF SORGHUM SACCHARATUM.

BY E. B. COWGILL.

In effecting the crystallization of sugar from the juice of sorghum *saccharatum* I observed carefully, with the aid of a lens, the several stages of the process.

The juice was first defecated by the usual lime process, and then reduced to a density, while hot, of 20° B. A portion of this liquid was introduced into a small experimental vacuum-pan. The vacuum was maintained at about 24 inches mercury by a spray of water in a receiver, and by hand pumping. Heat of a coal fire was applied through a water bath. The temperature remained at about 140° F. Opportunity was not available, except as hereafter noted, for determining the specific gravity of the syrup at the time crystallization commenced, but the sugar-boilers' usual test of drawing samples of the hot syrup between the thumb and fingers was made repeatedly. When the fibers thus drawn reached a length of about two and a half inches the syrup showed under the microscope a slight turbidity or cloudiness, somewhat resembling the effect produced by allowing a few drops of milk to fall into a glass of water. Examination by transmitted light showed the particles of the little cloud to be crystals, able to refract and reflect light. These crystals were so minute that no forms could be described, nor could they be discovered to have appreciable size; and only by their action upon light, which from its delicacy might easily have escaped observation, could the beginning of the crystallization be detected. Another phenomenon which usually precedes crystallization, and is often seen after the formation of microscopic crystals has taken place, may be easily confounded with crystallization: When a sample is removed from the vacuum-pan and placed upon glass for observation, the surface becomes cooled and somewhat rigid. As the reduction of temperature reaches the interior portions, contraction ensues, and with it minute flexures of the already cooled surface. These flexures refract and reflect light strongly, and these effects are liable to be mistaken for or to overshadow the less prominent but more beautiful effects of the crystals. A more unpardonable error is to mistake for crystals the curious-looking gaseous bubbles of various sizes which precede crystallization and sometimes continue long after the appearance of the cloud of microscopic crystals.

To increase the size of the infant crystals it is only necessary to "feed" them. Having continued the concentration of the syrup, in vacuo, until, by the thumb-and-finger test, fibers may be drawn four or five inches long, a small portion of fresh semi-syrup was added. No new crystals appeared to be formed from this fresh addition, but a portion of the sugar it contained seemed to gravitate to the microscopic crystals of the first portion. The growth, however, was so inconsiderable that only after several successive additions could the crystals be seen to have either size or form. The action upon light, however, became more distinct at each addition. What at first might have been confused with the refraction and reflection of the crumpled surface, or even with the shimmer of a liquid surface, was discernible even by unpracticed eyes as the true crystalline refraction and reflection. After a few more additions the clouded appearance was lost. Now a sample viewed through the lens by reflected light appeared like a miniature bank of fine, yellowish sand; the forms of crystals were distinct as they lay piled one upon another in the syrup. So greatly was I elated at this stage of my first experiment that the thermometer was neglected, and before it was suspected the temperature had risen to 160° F., and the crystals all disappeared. To renew them and again build them up to their former size was a work of several hours. This being done, the process of feeding

by fresh additions of syrup was continued until the crystals presented the diverse forms, from solid-looking truncated cubes to long, slender prisms which characterize cane sugar. But now the microscope was no longer needed, and the growth was so rapid that each successive addition of syrup seemed to produce an appreciable enlargement of the crystals.

NOTE ON A HABIT OF THE RED ANTS.

BY ROBERT HAY, JUNCTION CITY.

Two years ago Professor Snow and Mr. Savage directed the attention of the Academy to the fact that the red ant of the plains covered his large hills with glittering fragments of quartz, feldspar, and other bright minerals. Glass beads were also mentioned as occurring, and a general conclusion was arrived at that this bright material was not brought from underground, but gathered around the hill and used probably with reference either to the reflecting or radiating power of the polished surfaces on the solar heat. Since then the writer has had abundant opportunity of verifying the conclusion that the ants collected the material around and not within their mounds.

Early in the recent summer the writer saw a paragraph copied in another southwestern paper from the Dodge City *Times*, in which it was said that the ant-hills in that region indicated the presence of coal beneath the surface, as the red ants brought up fragments of it and placed it on their mounds. In the month of July we found that quite a number of persons at Dodge City had this idea. A talk we had with Editor Klaine (which he published) served to dispel this fond illusion, but it was interesting to observe the fact on which it had rested. In a walk of about seven miles easterly along the railway track from Dodge City, we observed about fifty ant-hills, and about half of them had fragments — bright, shining cubes — of coal among the quartz with which the hills were mostly covered. In Dodge City itself, on the rising ground north and for miles along the wagon road west, we found coal among the coverings of many of the ant-hills. The cause of this was not far to seek. It was very interesting to note that on the railway track a hill would be remarkable for the quantity of coal upon it, while another hill not twenty feet away had not a single black particle on it. Those having the coal were in the ditch close to the track, or on the prairie adjoining not elevated above the track, and there were always pieces of bright Trinidad coal breaking up by weathering, lying near, which had been dropped from some passing train. The hills without coal were upon high banks where such droppings were not available; or if lower, where no droppings of coal had taken place. It was the same wherever we found coal — some house was near where it had been used, or some roadway along which it had been hauled.

We have noticed further, that the ants will use other material. On the great gravel deposits of Colorado the quartz and feldspar are the prevalent coverings for these hills, but a few miles from Pueblo there are spots where the gravel has all disappeared, though it is found again only a few rods off. In some of these spots on cretaceous shale we found the mounds of the red ants without one speck of quartz, but covered entirely with thin, lenticular fragments of hematite, or limonite, from the nodules of that material which some layers of the shale contain in abundance. In places these decomposing nodules give a brown hue to several acres of slope, and ant-hills here are of the same color. In the gypsum hills of Barber county, Kansas, we found ant-hills glistening with fragments of selenite.

In short, we find the ants are somewhat like ourselves: they roof their houses with

the most available material—coal, hematite, quartz, or glass beads, even as men use clapboards, shingles, slates, or tiles.

In looking at the hills it always appears that we can easily gather a handful of the roofing material, but when we try, it is not so. It needs some little force to detach the particles. They are indeed a roof; they shed the water, so as to prevent the softer material of the building below from being washed away; and we still think that the brightest materials within reach are selected from some relation to the distribution of heat.

ADDITIONS TO THE CATALOGUE OF KANSAS BIRDS.

BY N. S. GOSS, TOPEKA.

Since the publication of my Catalogue of the Birds of Kansas, in 1883, the following additions have been made, and the same will appear in the new work, which awaits the receipt of "The American Ornithologist Union Check List of North American Birds," now in the hands of the printer, as I desire to follow its classification and nomenclature.

The three letters, "B.," "R.," and "C.," each followed by a number, stand respectively for Prof. Spencer F. Baird, Catalogue of 1858; Prof. Robert Ridgway, Catalogue of 1880; and Dr. Elliott Coues, Check List of 1882.

MERULA MIGRATORIA PROPINQUA. B.—. R. 7*a*. C. 2. Western Robin. A rare visitant in western Kansas. October 12, 1883, I killed two of the birds out of a flock of seven, at Wallace, Kansas.

THRYOMANES BEWICKI LEUCOGASTER. B.—. R. 61*b*. C. 72. Texan Bewick Wren. Resident; not uncommon in southwestern Kansas. Nests in deserted woodpecker holes, hollow logs, or any nook it may fancy; composed of sticks, roots, straws, and grasses, and lined with fur and a few downy feathers; quite bulky, generally filling the space, but in no case, I think, roofed over. Measurements of five eggs, taken at Corpus Christi, Texas, May 9, 1882: .63x.50; .63x.50; .63x.50; .63x.49; .62x.49; white, speckled with light and dark shades of reddish brown; thickest around large end; in form, oval.

ICTERIA VIRENS LONGICAUDA. B. 177. R. 123*a*. C. 145. Long-tailed Chat. A summer resident in the western part of the State; not uncommon. In habits and actions like the yellow-breasted, but note and song slightly different. The birds were reported by Prof. F. H. Snow, in vol. 6, page 38, Transactions of the Kansas Academy of Science, as "Taken along the Smoky Hill river, in western Kansas, by S. W. Williston, in May, 1877;" but by oversight omitted from my first Catalogue. Attention was immediately called to the same. (See Bulletin of the Nuttall Ornithological Club, vol. 8, page 227.) June 2, 1885, I shot two of the birds on Crooked creek, in Meade county, and saw several others.

VIREO ATRICAPILLUS. B. 247. R. 142. C. 185. Black-capped Vireo. Summer resident in the gypsum hills in southwestern Kansas. The habits of the birds are but little known. On the 11th of May, 1885, I found the birds building a nest near the head of a deep cañon; suspended from the forks of a small elm tree, about five feet from the ground, hemispherical in shape, and composed of broken fragments of bleached leaves, with here and there an occasional spider's cocoon, interwoven with and fastened to the twigs with fibrous strippings, threads from plants, and the webs of spiders, and lined with fine stems from weeds and grasses; above, it was screened from sight by the thick foliage of the trees, but beneath, for quite a distance, there was nothing to hide it from view. The material of which it was made, however, so

closely resembled the gypsum that had crumbled from the rocks above, that the casual observer would have passed it by unnoticed. I regret that I could not stay for the eggs, but as the birds are quite common in that vicinity (southeastern Comanche county), I trust that before another season passes I shall be able to describe the eggs.

PASSERCULUS SANDWICHENSIS ALAUDINUS. B. 335. R. 193*b*. C. 229. Western Savanna Sparrow. Migratory. October 14, 1885, I shot one of the birds, a male, near "Lake Inman," in McPherson county, and saw several others. I am inclined to think they will prove to be quite a common bird in the western part of the State, but they so closely resemble *P. sandwichensis savanna* that they have not been noticed. The birds are, however, considerably smaller and paler in color — a bleached race of the plains.

ZONOTRICHIA GAMBELI INTERMEDIA. B. 346. R. 207*a*. C. 277. Intermediate White-crowned Sparrow. Migratory. Quite common in the middle and western part of the State. Arrive the last of April to first of May.

PASSERINA CIRIS. B. 384. R. 251. C. 292. Nonpareil Bunting. Summer resident in southwestern Kansas. May 7 to 18, 1885, I found the birds quite common in the gypsum hills near the State line. Arrive the last of April to first of May. Begin laying the last of May. Nest in the forks of bushes and low trees, composed of grasses, sometimes of leaves at the base, and lined with the finer grasses and hairs. Eggs four or five; .70x.53; cream white, thinly specked and spotted with purple and reddish brown, thickest about large end; in form, rounded-oval.

SPHYRAPICUS VARIUS NUCHALIS. B. 86. R. 369*a*. C. 447. Red-naped Woodpecker. Migratory in western Kansas. Rare. I killed a pair out of three young birds found in the willows and cottonwoods thinly skirting the south fork of the Smoky Hill river, at Wallace, October 12th and 14th, 1883.

GEOCOCCYX CALIFORNIANUS. B. 68. R. 385. C. 427. Chapparral Cock. An occasional visitant in western Kansas. Mr. Charles Dyer, Division Superintendent of the A. T. & S. F. R. R. at Las Vegas, New Mexico, writes me that in September, 1884, he saw two of the birds near the railroad, and about fifteen miles east of the west line of the State, and that he has seen them quite often in Colorado, near the State line. The birds are known to breed as far east as Las Animas, and I feel confident that they occasionally breed in the southwestern corner of the State, a natural habitat of the birds; but unsettled and little known, especially as to its bird-life.

BUBO VIRGINIANUS SUBARCTICUS. B. —. R. 405*a*. C. 463. Western Horned Owl. October 29th, 1885, I shot a male in the timber skirting the south fork of Beaver creek, in Rawlins county.

BUTEO BOREALIS KRIDERI. B. —. R. 436*a*. C. 519. Krider's Hawk. October 12th, 1883, I killed a female near Wallace, and think I saw, during the day, another; but the birds at a distance so closely resemble the light phase of *Archibuteo ferrugineus* that I was not positive. They are birds of the plains, found from Texas to Minnesota.

HIMANTOPUS MEXICANUS. B. 518. R. 567. C. 601. Black-necked Stilt. Mr. W. H. Gibson, formerly of Topeka, now of Las Vegas, New Mexico, (taxidermist,) informs me that he saw three of the birds about the middle of June, 1881, on low, wet ground near the Arkansas river, at Lakin. Without doubt the birds occasionally breed in southwestern Kansas.

PORZANA NOVEBORACENSIS. B. 557. R. 575. C. 680. Little Yellow Rail. Summer resident. Rare. Prof. L. L. Dyche, Curator of Birds and Mammals, State University, writes me that April 18th, 1885, he captured one of the birds (a female) on

low, wet land, about five miles southeast of Lawrence. The specimen is mounted, and in the fine collection under his charge. It is the first bird, to my knowledge, captured or seen in the State. But this is not strange, as the birds inhabit the marshy grounds, and at the least alarm run, skulk and hide in the reeds or grass, and it is next to impossible to force them to take wing. Therefore seldom seen, even where known to be common. I enter the bird as summer resident, because they have been found both north and south of us, and are known to breed within their geographical range. Nest on the ground. The following description is from vol. I, North American Water Birds: "Its nest resembles the ordinary loosely-constructed one of this family. . . . Three eggs in the Smithsonian collection, (No. 7,057,) from Winnebago, in northern Illinois, measure respectively 1.08 inches by .85; 1.12 by .82; 1.12 by .80. They are of oval shape, one end slightly more tapering than the other. Their ground color is a very deep buff, and one set of markings, which are almost entirely confined to the larger end, consist of blotches of pale, diluted purplish brown; these are overlain by a dense sprinkling of fine dottings of rusty brown." [NOTE.—October 1st, Professor Dyche captured on the Wakarusa bottom lands, two and a half miles south of Lawrence, another of the little birds, a female, and he thinks a *young* bird. The lucky finds were both caught by his dog.]

GALLINULA GALEATA. B. 560. R. 579. C. 684. Florida Gallinule. Prof. F. H. Snow writes me, under date of October 20th, 1885, that since the publication of his "Birds of Kansas," in 1875, he has personally obtained in the State two specimens of Gallinula galeata. The first was captured by himself, June 14th, 1878, on the Hackberry, in Gove county; the second by a friend in the vicinity of Lawrence. The bird was entered in his catalogue on the authority of Professor Baird, and at the time of the publication of my catalogue in 1888 they were known to breed both north and south of the State, and therefore safe to enter as a Kansas bird. But my list only embraced the birds that came under my own observation, and that of others as reported to me. From the fact that the birds nest within their geographical range, and its capture so late in June, I now enter it as a rare summer resident. I have found the birds nesting in Wisconsin as early as the middle of May. Nest in rushes and reeds growing in shallow water or on swampy lands, build on the tops of old broken-down stalks, and the nests are composed of the same material, weeds and grasses; also the leaves of the cat-tail flag, when growing in the vicinity; a circular structure, and in some cases quite deep and bulky. Eggs usually eight to ten, 1.78x1.24; buff-white, thinly spotted and splashed with varying shades of reddish-brown; in form oval. One set of thirteen collected May 25th, 1878, on a bog in Pewaukee lake, Wisconsin, measured as follows: 1.63x1.18, 1.84x1.27, 1.67x1.18, 1.60x1.16, 1.67x1.18, 1.78x1.30, 1.81x1.29, 1.79x1.29, 1.88x1.27, 1.70x1.16, 1.80x1.30, 1.75x1.18, 1.80x1.28.

ANAS FULVIGULA. B. ——. R. 603. C. 709. Florida Dusky Duck. Migratory; rare. Arrive about the middle of March. Captured a female at Neosho Falls, March 11th, 1876. I have since shot one, and observed two others in the State. The birds were entered in first catalogue as *A. obscura*.

TACHYPETES AQUILA. B. 619. R. 639. C. 761. Man-of-War Bird. Frigate Pelican. A straggler. Mr. Frank Lewis, of Downs, Kansas, reports to me the capture of the bird on the North Fork of the Solomon river, in Osborne county, August 16, 1880. It was killed with a stone while sitting on a tree. The specimen has passed out of his hands, but he sends me a photograph of the bird, taken after it was mounted, which removes all previous doubts as to its identification. The birds are strictly maritime, and largely parasitical in habits. Their home is on the coast of tropical and sub-tropical America. They are known to be great wanderers along

the seaboard, but this is, I think, the first record of its being found away from the coast range, and to straggle so far inland it must surely have been crazed or bewildered.

LIST OF THE BIRDS FOUND BREEDING.

Thryomanes bewicki leucogaster: Texan Bewick's Wren.
Troglodytes ædon parkmanni: Western House Wren.
Icteria virens longicauda: Long-tailed Chat.
Vireo atricapillus: Black-capped Vireo.
Ammodromus caudacutus nelsoni: Nelson's Sharp-tailed Finch.
Passerina ciris: Painted Bunting—Nonpareil.
Pica rustica hudsonica: Black-billed Magpie.
Aquila chrysætus canadensis: Golden Eagle.
Rallus virginianus: Virginian Rail.
Porzana noveboracensis: Little Yellow Rail.
Gallinula galeata: Florida Gallinule.
Spatula clypeata: Shoveller.
Sterna antillarum: Least Tern.
Hydrochelidon lariformis surinamensis: Black Tern.
Podilymbus podiceps: Thick-billed Grebe.

METEOROLOGICAL SUMMARY FOR THE YEAR 1885.

PREPARED BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS, FROM OBSERVATIONS TAKEN AT LAWRENCE.

The chief meteorological peculiarities of the year 1885 were the low temperature of all its months except November and December; the ample and remarkably well-distributed rainfall; the low aggregate velocity of the wind for every month but August; and the most extraordinary wind velocity on our record (December 4th).

TEMPERATURE.

Mean temperature of the year, 51.01°, which is 2.28° below the mean of the 17 preceding years. The highest temperature was 96°, on July 16th; the lowest was 14.5° below zero, on the 10th of February, giving a range of 110.5°. Mean at 7 A. M., 45.24°; at 2 P. M. 59.23°; at 9 P. M. 49.79°.

Mean temperature of the winter months, 24.04°, which is 5.47°, below the average winter temperature; of the spring, 52.41°, which is 1.27° below the average; of the summer, 74.28°, which is 1.64° below the average; of the autumn, 53.33°, which is .43° below the average.

The coldest month of the year was January, with mean temperature 18.74°; the coldest week was January 15th to 21st, mean temperature 1.68° above zero; the coldest day was February 10th, mean temperature 4.12° below zero. The mercury fell below zero on twenty-one days, of which thirteen were in January, seven in February, and one in December.

The warmest month was July, with mean temperature 77.06°; the warmest week was July 18th to 24th, mean 81.66°; the warmest day was July 15th, mean 84.75°. The mercury reached or exceeded 90° on 27 days, (14 less than the average number,) viz.: three in June, seventeen in July, and seven in August.

The last hoar frost of spring was on May 8th; the first hoar frost of autumn was on October 4th; giving an interval of 149 days, or nearly five months, entirely without frost. The average interval is 155 days.

The last severe frost of spring was on April 13th; the first severe frost of autumn was on the 6th of October; giving an interval of 176 days, or nearly six months, without severe frost. The average interval is 199 days. No frost during the year caused damage to crops of grain and fruit, but the low temperatures of January and February were generally destructive to peach buds.

RAIN.

The entire rainfall, including melted snow, was 36.97 inches, which is 1.79 inches above the annual average. Either rain or snow, or both, in measurable quantities, fell on 103 days — one less than the average. On 20 other days rain or snow fell in quantity too small for measurement.

There was no approach to a drouth during the year, the longest interval without rain in the growing season being ten days, from August 12th to 22d.

The number of thunder showers was 31. There were two light hail storms during the year.

SNOW.

The entire depth of snow was 33 inches, which is 12.13 inches above the average. Of this amount eight inches fell in January, eleven inches in February, four inches in March, and ten inches in December. Snow fell on 27 days. The last snow of spring was on March 27th. The first snow of autumn was on November 12th — four days later than the average date.

FACE OF THE SKY.

The mean cloudiness of the year was 44.57 per cent., which is .08 per cent. below the average. The number of clear days (less than one-third cloudy) was 157; half-clear (from one to two-thirds cloudy), 112; cloudy (more than two-thirds), 96. There were 71 days on which the cloudiness reached or exceeded 80 per cent. There were 50 entirely clear and 45 entirely cloudy days. The clearest month was August, with a mean of 33.87 per cent.; the cloudiest month was April, mean 59.33 per cent. The percentage of cloudiness at 7 A. M., was 49.81; at 2 P. M., 45.06; at 9 P. M., 38.83.

DIRECTION OF THE WIND.

During the year, three observations daily, the wind was from the S. W. 305 times, N.W. 214 times, S.E. 187 times, N.E. 180 times, N. 87 times, S. 54 times, E. 46 times, W. 22 times. The south winds (including southwest, south and southeast) outnumber the north (including northwest, north and northeast) in the ratio of 546 to 481.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 123,013, which is 14,978 miles below the annual average for the 12 preceding years. This gives a mean daily velocity of 337.02 miles and a mean hourly velocity of 14.04 miles. The highest velocity was at the rate of 86.5 miles an hour, on December 4th; the highest daily velocity — the highest on our entire record — was 1,240 miles, on the 4th of December; the highest monthly velocity was 13,672 miles, in April. The three windiest months were April, November, and December; the three calmest months were January, July, and September. The average velocity at 7 A. M. was 13.02 miles; at 2 P. M., 15.29 miles; at 9 P. M., 13.73 miles.

BAROMETER.

Mean height of barometer column, 29.107 inches, which is .001 inch above the annual average. Mean at 7 A. M., 29.125 inches; at 2 P. M., 29.090 inches; at 9 P. M., 29.10[illegible] inches; maximum, 29.701 inches, on January 1st; minimum, 28.397 inches, on November 6th; yearly range, 1.304 inches. The highest monthly mean was 29.252

inches, in January; the lowest was 29.024 inches, in May. The barometer observations are corrected for temperature and instrumental error only.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 71.3; at 7 A. M. 82.4; at 2 P. M. 54.6; at 9 P. M. 79.9. The dampest month was January, with mean humidity 83.0; the dryest month was November, mean humidity, 65.0. There were 9 fogs during the year. The lowest humidity for any single observation was 10 per cent., on March 3d.

THE NINETEENTH ANNUAL MEETING.

TRANSACTIONS.

THE Kansas Academy of Science met in its nineteenth annual session in the rooms of the State Normal School, at Emporia, the meeting opening on the afternoon of the 17th, and continuing through the 18th and 19th of November, 1886. Papers accepted by the committee on publication appear in the following pages.

The election of officers for the following year resulted as follows:

President—J. D. Parker.

Vice Presidents—J. R. Mead, E. H. S. Bailey.

Secretary—E. A. Popenoe.

Treasurer—I. D. Graham.

Curators—F. W. Cragin, L. L. Dyche, D. S. Kelly, N. S. Goss, A. H. Thompson.

Librarian—F. W. Cragin.

The address of the first evening session was given by Dr. John C. Branner, of the University of Indiana, upon the subject, "Geologists, Professional and Unprofessional;" of the second evening session by the retiring President of the Academy, Prof. E. L. Nichols, of the University of Kansas, upon "The Sky." At the various sessions the following papers, among others, were read:

ON BLACK AND WHITE.

BY EDWARD L. NICHOLS, PH.D.

In the spectrophotometric study of pigments, the selection of a suitable standard of color is of considerable importance. The ideal standard would be a body which reflects all wave-lengths of the visible spectrum equally well; but in practice this normal white cannot be obtained, and it becomes necessary to adopt as a working standard some substance which gives a fair approximation to the normal white, and having selected this, to determine as accurately as possible its variations from that standard.

It is my object in the present paper to describe some determinations of the character of certain pigments which had been selected as standard whites in the spectrophotometric analysis of color. The mere inspection of white pigments with the unaided eye brings to view marked differences of tint, the existence of which is for the most part unknown except to those who have had occasion to make careful comparisons of such substances; and these differences are sufficiently pronounced to lead to the rejection of all but a very few substances on the part of one seeking for a standard white. Of these few, even the best are far from satisfactory, and I have found none which, to the unaided eye, approaches more nearly the ideal standard than the carbonate of magnesium. The oxide of the same metal, which when prepared by burning magnesium ribbon or wire, gives a very brilliant white, loses splendor when taken in bulk, and appears at a decided disadvantage when compared with the carbonate.

The carbonate of magnesium possesses the advantage of cheapness, and it may

be obtained commercially in cubes or rectangular blocks of convenient size and the requisite degree of firmness, the surfaces of which are easily removed by scraping as often as they become soiled. These advantages, coupled with the fact that it appeared to the eye to be a very nearly perfect white, led to its adoption as a working standard in my spectrophotometric study of pigments[1] and of the color of the sky.[2]

An inspection of different commercial specimens of the carbonate, placed side by side, discovered such differences of tint as to make it impossible to select the one most suitable for a standard. The tendency is in such a case, to accept as white the one presenting the most brilliant appearance, and to regard all others by comparison as yellowish or creamy, just as one is apt unconsciously to adopt the sharpest of a series of musical tones of nearly the same pitch as the standard, and to regard the rest as flat.

In either case the result of the comparison is almost sure to be misleading. It becomes necessary, therefore, to subject the specimens to a careful spectrophotometric analysis, and to adopt that one as standard which shows the least deviation from the true white.

This determination is a matter of considerable difficulty. It involves the comparison, wave-length for wave-length, of the spectrum of the light reflected by the pigment, with the direct spectrum of the light illuminating it. The intensities of the direct and reflected spectra are so very different as to make this comparison exceedingly unsatisfactory. Any reduction of the intensity of the direct spectrum, by means of absorbing media or by reflection, is inadmissible, since we have no substance at command which will absorb or reflect different wave-lengths in precisely the same proportion. The use of a revolving disk with slits of adjustable width might be regarded by some as free from objection; but it is a matter of serious question whether the comparison of an intermittent ray with a persistent ray, even of the same wave-length, is in any degree trustworthy.

A source of error, unavoidable in any form of spectrophotometer, viz., slight modifications on the one hand by selective absorption and reflection in the Nicols prisms and on the other hand in the prisms or mirrors by means of which the unpolarized ray is brought to the slit of the collimator, cannot be eliminated. But these effects are fortunately small, and may be allowed for when their amount has been approximately determined. In the choice of the source of illumination one is limited to diffuse daylight, which is unfortunately subject to most perplexing fluctuations in intensity and quality alike, and to the use of the gas or petroleum flame or of the incandescent electric lamp — sources which, at their best, have little to be desired in the matter of constancy, but which are of such small intensity and so low in temperature as to seriously affect the accuracy of the comparison, even in the brightest parts of the spectrum, and to render it impossible to carry the measurements much beyond the neighborhood of the G line. In spite of these disadvantages, I found that the most trustworthy results were to be obtained by making comparison in an otherwise dark room, using as the sole source of illumination the flame of a "bat's-wing" gas burner.

The spectrophotometer used in these measurements was of the form described in the researches mentioned in a previous paragraph. In this instrument the spectra to be compared are brought into vertical juxtaposition in the eye-piece of an ordinary one-prism spectroscope, equal wave-lengths in the tube being everywhere in the same vertical straight line. The brighter of the two spectra was polarized by

[1] American Journal of Science. Vol. 28, Nov., 1884.

[2] Proceedings of the American Association for the Advancement of Science, Ann Arbor meeting, 1885. Vol. 34, p. 78.

passing the ray through the two nicols in front of the slit, the first of which was free to revolve, while the second was fixed with the longer diagonal of its faces parallel to the slit. By revolution of the first nicol this spectrum could be given any desired intensity, from that which it possessed when the polarizing planes of the two nicols were parallel, to zero, when the nicols were in position of extinction. The intensity of this spectrum was indicated by a finger attached to the movable nicol, which finger moved over a graduated circle. The ray producing the other spectrum, reflected from the surface of the pigment to be tested, entered the slit by total reflexion from the surface of a small, right-angled prism, the edge at one of the acute angles of which was at right angles to and in contact with the middle of the slit. In other respects, the instrument was an ordinary, one-prism spectroscope, into the eye-piece of which had been inserted a diaphragm containing a small, narrow, vertical slit.

If such an instrument be set up in front of a gas flame, so that the direct rays of the flame will form the polarized spectrum, and the pigment, the whiteness of which is to be tested, be placed above the reflecting prism at the slit so that its surface is illuminated by the same flame, and by that alone, certain of the rays reflected by the pigment will enter the upper half of the slit and form the unpolarized spectrum.

Were this pigment a true white, the reduction of the direct spectrum necessary to render these spectra equally bright would be precisely the same throughout their entire length. Any deviation from true whiteness manifests itself by undue brilliancy or weakness of some components of the light reflected by the pigment.

The amount of this variation may be measured, moreover, by going through the spectrum from end to end and noticing for each wave-length the position of the movable nicol at which that particular ray from the direct flame equals in intensity the corresponding ray reflected by the pigment. The spectrum of the pigment under these circumstances was very faint, but by taking the precaution to guard the retina throughout the experiment from the fatigue which follows exposure to even moderately bright objects, it was found possible to obtain a series of comparisons of the reflexion spectrum of a block of magnesium carbonate with the direct spectrum of the flame illuminating it.

To avoid even the loss of sensitiveness of the eye involved in reading the position of the movable nicol, it was necessary for two persons to take part in the measurements, one observing at the eye-piece of the instrument and keeping his eyes constantly in the rested condition upon which accurate settings so much depended, while the other moved the rotating nicol to the position indicated by the observer, read off that position and the wave-length to which the reading corresponded, made the necessary notes, and kept the apparatus in proper adjustment. This plan served another very important end. The movement of the Nic-

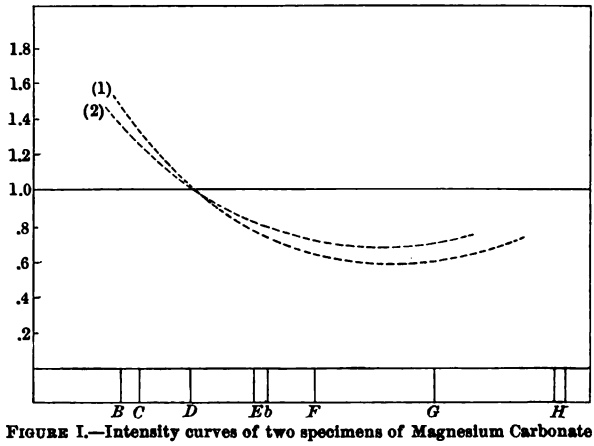


FIGURE I.—Intensity curves of two specimens of Magnesium Carbonate

ol's prism necessary to bring about the equality of the two spectra was out of the direct control of the observer, who thus relied upon his visual perception, entirely unbiased by the knowledge that the setting which he was directing his assistant to make differed in this respect or that from a looked-for result. The advantage of such an arrangement in work of this kind is very great. The personal equation in photometry of all kinds is very large, and in the photometry of the spectrum it is especially troublesome.

To further eliminate the personal element, my assistant, Mr. W. S. Franklin, duplicated nearly every series of observations. The result of our measurements upon the reflexion spectrum of this block of magnesium carbonate is shown in Curve I, Figure I. Abcissæ are wave-lengths, the spectral regions being denoted by the positions of the chief Fraunhofer lines. Ordinates are intensities, that of the region of the D line being taken as unity. A true white possessed of the same reflecting power as this block of magnesium carbonate would have as its curve of intensities the horizontal dotted line shown in the figure. Deviations from this line indicate, for each portion of the spectrum, the variation of the pigment from true whiteness. It will be seen from the figure that this specimen reflected a greater proportion of the red and less of the wave-length shorter than D than a true white would have done. Another specimen of the same substance gave a curve of quite the same character, No. 2, Fig. I. Its color, in a word, was a red of an exceedingly small degree of saturation, and the inspection of other whites has led me to the conclusion that the same peculiarity is common to most white pigments, excepting when viewed in very thin films. The curve of this specimen of magnesium carbonate once obtained, the measurement of others was a comparatively easy matter. This specimen was used as a working standard, with which the pigment to be measured could be compared.

A comparison of several other white substances revealed the presence of blue adulterants. The addition of a very small quantity of ultramarine or indigo compensates for the preponderance of the longer wave-lengths in the spectrum of these pigments, and adds greatly to their brilliancy.

The intensity curves of specimens of white paper, of plaster of paris prepared for dentists' use, and of carbonate of magnesium, show, unmistakably, the presence of this blue coloring matter. Although to the naked eye the only effect was increased brilliancy of tone, the adulteration unfits the substance altogether for use as a standard white. These curves are shown in Figure II. The reflexion spectrum of the paper possesses a well-marked maximum between the Fraunhofer lines F and G, while the intensity of the rays beyond the G falls off to an amount less than that belonging to a true white. The

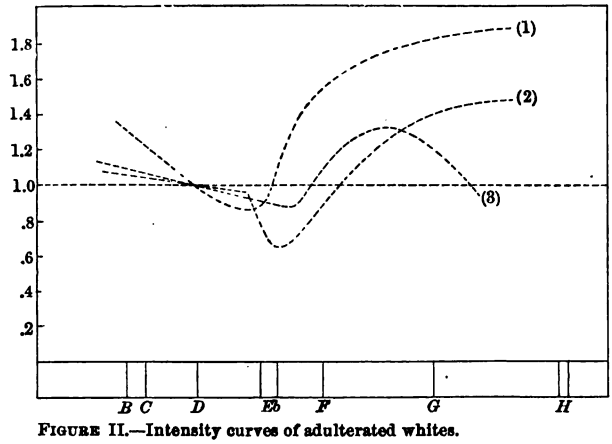


FIGURE II.—Intensity curves of adulterated whites.
(1) Plaster of Paris. (2) Magnesium Carbonate. (3) Paper.

coloring matter used in this specimen is probably indigo, but the plaster of paris and magnesium carbonate were undoubtedly colored with ultramarine, in consequence of which the entire violet end of the spectrum is much brighter than in a true white. Thus the spectrophotometer affords a means of showing the presence of such coloring matters in quantities much too minute to be detected in any other way.

The preponderance of the longer wave-lengths in the spectrum of unadulterated white pigments is not due to selective reflexion, but is produced by absorption of the more refrangible rays in process of transmission, so that those portions of the light which penetrate to a considerable depth and are reflected internally, acquire a very decidedly reddish tone, which although diluted by mixture with the unmodified light reflected at the surface, gives the creamy tint common to such substances. That this is true can often be shown by coating a piece of glass with the substance in question in the form of powder. Such a coating, when of considerable density, is found to transmit light of a strong orange or red color, which disappears whenever the coating becomes sufficiently thin. The appearance of such coatings by reflected light shows the modification due to the admixture of the red rays reflected internally, sometimes in a very striking manner, and the color, as the coating becomes thinner and thinner, invariably tends toward blue. In the case of some substances, notably of the well-known blowpipe films of antimony oxide, the blue appearance is very pronounced The spectrophotometric analysis of these blue films and of the blue precipitate in very dilute opalescent solutions—for instance, the solution of hypersulphate of soda from which the sulphur has been precipitated by an acid —led to a surprising result. The fumes of antimony before the blowpipe, having been caught upon the surface of a pane of white glass, showed when viewed by reflected light the usual appearance of a white film shaded off by insensible gradations, as the coating became thinner, to a delicate sky-blue. By transmitted light the thicker portions of this film were orange, the color disappearing until in those parts which presented a blue appearance by reflected light, no absorption effect could be detected.

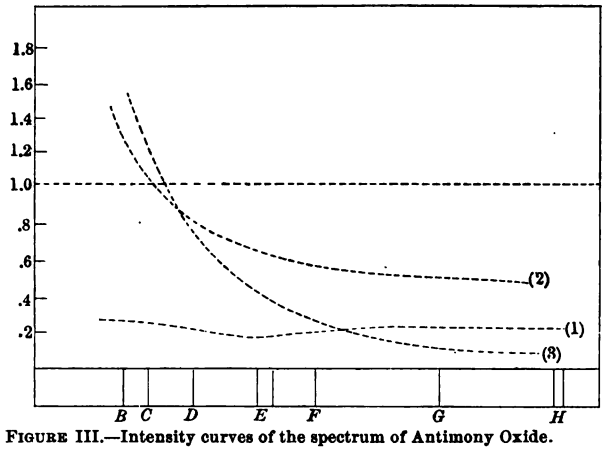


FIGURE III.—Intensity curves of the spectrum of Antimony Oxide.
(1) Reflexion spectrum of a thin film. (2) Reflexion of a thick film.
(3) Absorption spectrum of a thick film.

The absorption spectrum of the denser part of this film and the reflexion spectra of the thickest and thinnest portions were subjected to a photometric analysis.

The result is shown in Fig. III.

The thin film, in spite of its unquestionably blue appearance to the unaided eye, gave a very faint spectrum in which no excess of blue or violet rays could be detected with certainty, the energy curve approaching more nearly that of a true white than did the curve of any so-called white pigment which I have investigated.

The excess of blue and violet in this case, if such existed, was certainly very much less marked than in the adulterated whites already mentioned. The thick portions of the same film which were accepted by the eye as being of unusually pure whiteness, showed the influence of the absorption of the shorter wave-lengths, and the absorption spectrum of the same portion possesses a curve in which the red end of the spectrum is at least thirty times brighter than the region midway between the G and H line.

It seems evident, from this result, that we have to do in the antimony film with a so-called *subjective blue;* with a color, in other words, which does not arise from any marked excess of violet rays; and I believe the antimony film to be in this respect typical of a very large class, viz., of all opalescent media. I am aware that this view is not in accordance with those generally held concerning opalescence, it being generally supposed that in such substances the incident ray is selectively divided into two components, one of which, containing an excess of the longer wave-lengths, gives the film its ruddy appearance when viewed by transmitted light, while the blue appearance by reflected light is to be ascribed to the quality of the reflected rays.[1]

It is commonly maintained that the particles of which such films are composed reflect blue light and transmit the red because of their small size. I have long regarded this explanation as unsatisfactory, and the analysis of the reflexion and absorption spectra just described, which constitutes, I believe, the first attempt to measure spectrophotometrically the light reflected and transmitted by an opalescent medium, affords us evidence that these substances *reflect* all visible rays equally well, *absorb* the shorter wave-lengths, and transmit a corresponding excess of red light.

I have assured myself, moreover, by an inspection of the antimony films under the microscope, with properly-managed illumination from above, that the particles of those portions of an antimony film which appear blue to the unaided eye, though small, are capable of reflecting white light. Under such circumstances all traces of blue vanish, and the field of view shows the particles of antimony oxide, of a pure white, very sparsely distributed upon a black background. These particles, which are readily measured by means of the eye-piece micrometer, vary in diameter from .0007 millimeters to .0015 millimeters; and portions of the same film, when thick enough to appear perfectly white to the naked eye, present in the microscope a field in which the particles are of the same sizes and of the same individual appearance, but in which the number per unit of area is much greater.

The hypothesis that the differences of color in such films are due to differences in the size of particles, can, moreover, be disposed of by the following very simple but conclusive experiment: If antimony be burned in the flame of a blast lamp and a piece of smoked glass or charcoal be exposed for an instant to the fumes, the thin film first formed will present the color usually obtained before the blowpipe, and it may be converted into the white film by a longer exposure. In this case, the change of color is produced by the accumulation of the same particles which, at the beginning of the experiment, went to build up the blue film, and the change in appearance cannot be ascribed to any arrangement in order of sizes upon different portions of the glass, but is evidently due to the increasing thickness of the deposit.

A spectrophotometric analysis of the opalescent solution produced by precipitating sulphur from a solution of hyposulphite of soda gave results similar to those obtained with the antimony film. The sulphur precipitate, as is well known, pre sents by reflected light, in its incipient stages, a blue color quite as striking as that of the antimony film. This changes to a milky white as the precipitate becomes

[1] See C. H. Kayle, Am. Journal of Science.

denser; and the solution, in which at first no selective absorption can be noticed, transmits, as the experiment proceeds, light in which red and yellow become more and more dominant.

Fig. IV shows the intensity curves of the reflexion spectrum of the hyposulphite solution in its blue stage and in the milky stage, also the absorption spectrum of the latter.

In the same figure is given, for purpose of contrast, an intensity curve obtained from artificial ultramarine, the result of measurements which have been already published.[1]

It will be seen upon inspection of these curves, that the sulphur precipitate, even in its first stages, shows no measurable excess at the violet end of the spectrum; that this curve differs from the denser precipitate only in intensity; and that both curves represent within narrow limits the spectrum of the true white.

The absorption spectrum of this solution (Curve 3) shows a decided excess in the red and yellow, and an equally unmistakable deficiency toward the violet.

The appearance of a pronounced and very beautiful blue in substances which reflect light of an almost pure white is, I believe, by no means confined to the cases under consideration here. Two important factors in the production of these subjective blues may be briefly referred to. In the first place, we unconsciously adopt as our standard of whiteness, light reflected by pigments which are really of a decidedly yellow-reddish tone. The excess of yellow and red in the ordinary so-called whites of every-day life leads us to the adoption of this false standard, because, with the probable exception of snow, all white substances with which we have to do possess this peculiarity.

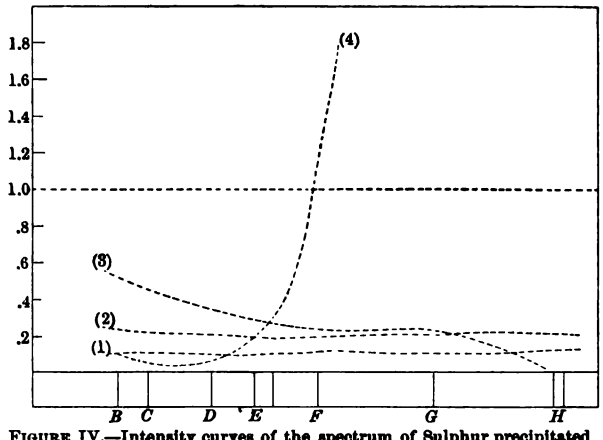


FIGURE IV.—Intensity curves of the spectrum of Sulphur precipitated from a solution Hyposulphite of Sodium.

(1) Reflexion spectrum in the incipient (blue) stage. (2) Reflexion spectrum in the "milky" stage. (3) Absorption spectrum of the solution in the "milky" stage. (4) Reflexion spectrum of artificial Ultramarine.

Any substance reflecting all wave-lengths in the same proportion will be regarded as blue by comparison, and whenever a white pigment appears in exceedingly thin films against a black background, and its deviation from the true white by absorption disappears, another factor enters, the importance of which is, I believe, greatly underrated.

The increasing delicacy of the eye to the more refrangible rays of the spectrum as the light reaching the retina diminishes[2], comes powerfully into play in the case of these thin films, reinforcing an impression to which the judgment is already biased

[1] Spectrophotometric Study of Pigments, Am. Journal of Science. Vol. 28.

[2] Albert; Wiedemann's Annalen. Vol. 16, p. 129.

by the real contrast already mentioned, until we accept as blue what is actually only a pure white of a very low degree of brightness.

Scarcely less important in photometry than the choice of our standard white, is the selection of a suitable black.

The ideal black, a substance which absorbs all wave-lengths completely, does not exist; and all blacks attainable in practice are simply pigments of very small reflecting power. A pure white of this kind would furnish what might appropriately be termed a *neutral* black, one, namely, which although possessed of some power of reflexion, would reflect all wave-lengths equally well.

The value of such a substance would be great, and would increase in proportion as its reflecting power was insignificant. All other blacks may be regarded simply as colored pigments of low brilliancy.

The superiority of lamp-black is so generally recognized, and its use in photometry so common, as to render it desirable to gain as accurate a knowledge as possible of the character of its spectrum. Its transparency to rays of the infra-red regions has long since been established, and its average reflective power for light has also been determined. Its spectrum, even when illuminated by direct sunlight, is so faint as to make its photometric analysis quite unsatisfactory, but the methods already applied to other pigments were found sufficient to give a tolerable indication of its character.

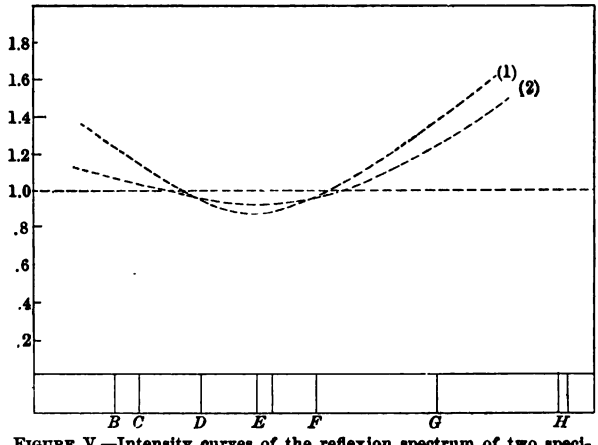


FIGURE V.—Intensity curves of the reflexion spectrum of two specimens of Lamp-black.

Fig. V shows the intensity curves of the spectrum of two specimens of lamp-black.

The deviations from the straight line, which would be characteristic of a neutral but imperfect black, are such as enable us to define lamp-black, not as a white of diminished brightness, but as a purple in which red is the dominant hue, but in which violet also greatly preponderates over the wave-lengths which form the central region of the visible spectrum. Fortunately, none of the visible rays reflected by this pigment are of sufficient intensity to prevent its adoption as the standard black in most spectrophotometric work, but the character of its intensity curves is such as to warrant the suspicion that black pigments will be found, upon analysis, to differ as widely from the ideal standard as do those substances which we are in the habit of regarding as white.

UNIVERSITY OF KANSAS, November, 1886.

COAL MEASURES OF LYON COUNTY.

BY D. S. KELLY, EMPORIA, KANSAS.

Lyon county is situated near the center of the vast region of Kansas known as the Upper Coal Measures, and near the eastern border of the division of these measures sometimes called the Permian strata. This county is as far west as we should expect to find coal outcrops in this latitude. Many attempts were made to find coal in this county before the efforts met with anything like success. About eight years ago borings were made near Emporia which resulted in failure to find coal, except some very thin layers. Along ravines, in various parts of the county, outcrops may be found which show evidences of coal, but not until within the last two or three years have any of these proved workable coal-bearing strata. The first opened which yield coal in any paying quantities are those in the eastern part of the county, near Neosho Rapids, of which mention is made in the State Agricultural Report for 1885.

Within the past year coal has been found at a number of places in the northern part of the county. On the farm of Henry King, eight miles north and two miles east of Emporia, veins nine inches thick have been reported. Near the new town of Admire, recently, on sinking a shaft to the depth of twenty-eight feet, coal of good quality was found to be seventeen inches thick.

For some time past it has been thought that coal existed in paying quantities near Emporia. Four years ago an unsuccessful attempt to find coal was made about three miles to the northwest of Emporia. No further attempts were made in that direction, until a short time ago a company of three men, Wise, Fritz, and Reeves, leased a number of acres a little to the northwest of the place mentioned above. About two months ago they began to drive tunnels into the hill from a ravine, and met with encouraging results. A few days ago I visited these mines, and found that four tunnels had been driven into the hill at short distances apart, the longest one being 175 feet. Nowhere has the vein of workable coal been less than eleven inches. At some places it seems to have been thrown up in folds, where it is seventeen inches thick. The quality of this coal, for some distance in, is about the same as the Fort Scott red coal; then a black coal is reached, which compares favorably in quality to the Osage shaft coal. The men who are in charge of this work are very confident that the enterprise will be a paying one, and expect soon to put a force of thirty or forty men at work.

NOVEMBER 17, 1886.

HISTORICAL SKETCH OF GEOLOGICAL WORK IN THE STATE OF KANSAS.

BY ROBERT HAY, U.S.G.S., AND A. H. THOMPSON, D.D.S.

Being in the center of the continent, touching the great river Missouri, and having within its borders several important tributaries that find their way to that stream or the greater Mississippi, Kansas has been ofttimes on the route of explorers. Some geological features and some of the minerals of its formations have had notice from the earliest times.

In 1724 De Bourgmont, a Frenchman, passed up the Kaw valley, and the very slight notice he makes of mineralogy enables us to see that he saw those glacial boulders which are found in the northeast of the State. His words are (London translation of Du Pratz Hist. of Louisiana, 1763):

"One could observe pieces of rock, even with the ground, . . . and in the meadows a reddish

marble standing out of the earth one, two and three feet; some pieces of it upwards of six feet in diameter."

Lewis and Clark, whose expedition passed up the lower part of the Missouri in 1804, besides noticing that this region had limestone in it, only give the further geological information that the bars of the Missouri river had pebbles of pit coal, and that the bluffs of the river were "cliffs of yellow clay."

Major Zebulon Montgomery Pike's expedition, in 1805–6–7, spent much time in Kansas, but gives no geological information, simply referring to reported minerals and salines.

Henry R. Schoolcraft, who spent some time in this Western territory, 1818–19, has this remarkable statement: "Volcanic mountains are reported to exist on the waters of the Kansas."

In 1819–20 Major Long was sent out by the Government, and by his direction Prof. Thomas Say, accompanied by Mr. Jessup, a geologist, was sent through northeastern Kansas to make geological investigations. Mr. Jessup noted the horizontal position of the strata of limestone and their prolific yield of fossils, and their "connection with coal strata." He concluded that the formations were of "secondary" age. This was when the main geologic divisions were known as primary, transition, secondary, tertiary, and alluvial. A map accompanies the report, and a line on it through what are now the counties of Pottawatomie and Wabaunsee is designated as "the western limit of the limestone and coal strata connected with the Ozark mountains." West of this is marked "deep, sandy alluvion," and then, stretching to the mountains, is located the "*Great American Desert.*"

The two expeditions led by Capt. John C. Fremont (1842–3–4) passed up the Kaw, Smoky and Republican valleys. The geological collections were placed in the hands of Prof. James Hall, of New York, who in the report published in 1845 gives figures of some fossils. Some of these, obtained by the expedition on the Smoky Hill river about longitude 98°, are said to be probably of Cretaceous age.

In 1849, Capt. Howard Stansbury located the military road from Fort Leavenworth by way of the Big Blue and Fort Kearney to Salt Lake. Collections of fossils were made in northeast Kansas and west in Nebraska. Prof. Hall reports on those as far as the Blue as belonging to the Upper Carboniferous period. Beyond the Blue, cretaceous rocks were reported.

Capt. Marcy's report (1852) of the expedition to the Red river refers to the existence of gypsum north of the Arkansas river (in Kansas).

Reports on the geology of Missouri give some notice of Kansas formations near the boundary of the two States. That of Prof. G. C. Swallow, in 1855, refers to the position of the Loess on the Missouri river, and also to the similarity of the rock strata on each side of the river where it touches Kansas.

Prof. Swallow and Maj. F. Hawn, in 1858, published an extract from the Transactions of the Academy of Science, under the title of "The Rocks of Kansas." Specimens collected by these gentlemen were sent east, and a paper by Mr. Meek, read at the Albany Institute (N. Y.) the same year, says that some of them were from Permian strata.

A Missouri report, published in 1873, gives observations relating to Kansas from 1855 to 1871, by Prof. Broadhead and Drs. Hayden and Shumard. We shall have occasion to notice further along Prof. Broadhead's later work.

For the foregoing information we are indebted almost entirely to a paper on the "Bibliography of Kansas Geology," read before the Kansas Academy of Science, in 1883, (but not published in the Transactions,) by the able Secretary of the State Historical Society, Hon. F. G. Adams, who has kindly allowed us to use the MS.

Summarizing the items given, we find that at the epoch when Kansas became a State the knowledge of the geological formations within her borders was limited to that contained in the following statements:

1. The Bluff or Loess was conspicuous in the northeast.
2. The Glacial (red) boulders had been observed.
3. The rocks of the eastern part of the State were of Carboniferous age, bearing coal.
4. Permian strata, or rather fossils, had been recognized.
5. Cretaceous formations were believed to be in middle Kansas.
6. Gypsum was reported to exist in the same region.
7. Sandy alluvion plentiful west.

The STATE of Kansas began to do scientific work while it was still young. The organic act, by which in 1861 the Territory became a State, makes provision in advance for important educational facilities. While the civil war was in progress the educational scheme so foreshadowed was put into operation, and the State University, the State Normal College, and the State Agricultural College, were established on what has proved to be an enduring foundation.

During the same period Kansas began by act of the Legislature a GEOLOGICAL SURVEY OF THE STATE. This act became law February 15, 1864. By it the Governor and Senate were to appoint a State Geologist for the term of one year — from March 1, 1864, to March 1, 1865. This State Geologist was "to proceed to classify the rocks and soils of each county;" "to visit and analyze salt springs;" "investigate coal formations, and other mineral deposits, by the appliances known to the departments of geology and mineralogy;" "analyze the soils of the settled counties;" "collect and label a geological cabinet;" and do other things necessary to a thorough survey of the State. The expenditure was not to exceed three thousand five hundred dollars, and it does not appear that the whole of this sum was used. Prof. B. F. Mudge became State Geologist; Major Hawn was designated as Assistant Superintendent of the Survey; Prof. G. C. Swallow, Paleontologist; Tiffin Sinks, M. D., Chemist and Meteorologist; C. A. Logan, M. D., Botanist, and to report on the sanitary relations of the State.

The work of Prof. Mudge and his coadjutors was, of course, limited by the limited means at their disposal. The report of this year's work by Prof. Mudge was not printed till 1866, when it was issued by the State Printer, Hon. John Speer. It is a pamphlet of 56 pages. Considerable attention is given in this report to the items of coal and salt. In connection with the former is given some account of the boring for that mineral which had then begun at Leavenworth, and a geological section of the strata of Leavenworth county is given to a depth of four hundred feet. This section was verified to a remarkable degree by the progress of the shaft, which finally reached coal at a depth of over seven hundred feet. With regard to salt, a full description of Tuthill salt marsh, in Republic county, is given, and references made to other developments of salt brines in wells, streams, and springs. Some of these are compared with the sources of salt utilized in New York and elsewhere, and analyses, methods of manufacture are also given in detail. That advance had been made in the geological classification of rock formations of the State, is seen from the fact that Prof. Mudge recognizes in order the following groups of strata:

1. Coal measures.
2. Permian.
3. Triassic.
4. Cretaceous.
5. Drift.
6. Loess.
7. Alluvium.

It would appear that the development within the State either of the Sub-Carboniferous or of the Tertiary deposits was unknown. In the short notice given to the Cretaceous deposits, which had received very little examination, there is a foreshadowing of what was eventually discovered many years after, that the Kansas Cretaceous system yields true chalk.

In 1865 the Legislature passed another act, which did not limit the time for which the State Geologist should be appointed to one year. It was further an improvement on the former act, in that it authorized an expenditure of $7,500 for the year. Prof. Swallow became State Geologist. Prof. Mudge was not connected with the Survey; the other members were as before. The report published by John Speer at Lawrence in 1866 is an unbound volume of 192 pages. Drs. Logan and Sinks each have reports in it on their several departments, the former discussing the facts of the climate as related to health and various forms of disease, and the latter showing the rainfall and other elements of meteorology as they could at that time be recognized. As the Legislature had prescribed work to be done in each county, this volume has a special report on the geology of Miami county, which gives a section of the formations found therein and investigates questions of petroleum and iron ore as well as coal. Major Hawn contributes to the report notices of eight counties. These are not nearly so full as that of Miami county, which appears to have been pretty thoroughly examined as a typical region of the coal-measure epoch. The counties of which the briefer reports are made are, Brown, Doniphan, Chase, Lyon, Linn, Butler, Osage, and Morris. The Bluff (Loess) is recognized as occurring in the counties of this list which are furthest west, Lyon, Chase, and Morris. It is spoken of also as occurring at the *northwest corner of the State*, in the Republican valley. The rocks of these three counties are described also as permian, and also the strata of Butler county with a slight exception.

The main body of the report of Professor Swallow treats of the formations of Kansas in the following order:

System I. QUATERNARY. *a.* Alluvium. *b.* Bottom prairie. *c.* Bluff. *d.* Drift.

System II. TERTIARY. In western Kansas, but not yet examined.

System III. CRETACEOUS. In central Kansas, only partially examined. Brown, ferruginous, yellow and buff sandstone. Generally classed as Cretaceous, "but saw no proof of age."

System IV. TRIASSIC. Gives these localities: Republican, Smoky Hill and Cottonwood rivers; Gypsum, Turkey and Fancy creeks. Distinguishes ten series of strata (Nos. 2 to 11), and gives a thickness of 338 feet.

System V. PERMIAN. Nos. 12 to 30. Thickness 141 ft. 1 in. Lower Permian, Nos. 31 to 84. Thickness 563 feet.

System VI. CARBONIFEROUS. *a.* Coal measures, 1,647 feet thick. *b.* Lower coal measures, 353 feet. *c.* Lower Carboniferous, 120 feet.

The "coal measures" (*a*) are divided into the following groups or "series," viz.: Upper coal measures, Chocolate Limestone series, Stanton Limestone, Cave Rock, Spring Rock, Well Rock, Marais des Cygnes coal, Pawnee limestone, Fort Scott coal, and Fort Scott marble series.

This report is the last that was issued by State authority. It refers to drawings of sections and lists of fossils that were never published. No further appropriations have been made for this work by the Legislature. We have given some of the details of the work, to indicate what progress had been made, and as a basis of comparison to show succeeding advancement. It were bootless to discuss the reasons for the discontinuance of the survey, as the appropriations were stopped before the report was distributed. When it was issued the work of Professor Swallow was

severely criticised by scientists in the East, and it would appear that the report erred in making exact statements where only approximation was possible, and in attempting too much by too rapid exploration in obedience to an unreasoning public demand for immediate economic results.

Had the work commenced by Messrs. Mudge and Swallow been continued until now, a worthy work would have been done. Exactness would have come with time, and the economic value would have been great. This would have been especially so in saving the wasteful expenditure of capital in useless prospecting. Since the date of these reports scores of thousands of dollars have been expended to no purpose in prospecting for coal, where a skilled State geologist would have advised with authority.

Though the State has not directly procured the doing of any more scientific work, yet indirectly she has aided in the diffusion of knowledge of the geological formations within her borders, and advance in definite knowledge has been made by the enthusiasm of individuals. B. F. Mudge became Professor of Geology at the State Agricultural College, and devoted his holidays to making geological explorations and paleontological collections. Later, he collected in the interest of Yale College. Before his death, in 1879, through the published reports of his work the general geology of the northern half of the State, and also that of the southeastern region, became known with a fair amount of certitude. The great features were soon recognized by Prof. Mudge, and his broad experience enabled him at times to give shrewd guesses as to details, that were afterwards verified by actual discovery.

In 1875 Prof. Mudge contributed an article on the geology of western Kansas to the national reports of geological and geographical surveys, made under the charge of Dr. Hayden. In this he recognizes three cretaceous groups, viz., the Dacotah, the Niobrara, and a group between them, which he provisionally named Fort Hays group. He also definitely allotted the Triassic (?) strata of Swallow's report to the Permian below and the Cretaceous above. The Tertiary was classed as Pliocene. This shows that considerable advance had been made in the study of west and mid-Kansas formations.

In the same year Prof. Mudge, as Geologist of the State Board of Agriculture, and in the fourth annual report of that Board, published an article on the geology of Kansas. In the biennial report of that Board for 1877–8 he had also an article on the same subject, which was illustrated with map, drawings and sections. In some points following the line of the articles of 1875, we notice the greater prominence of points of economic importance. The formation in the southeast, which now is yielding abundance of lead and zinc, is described fully, and recognized as belonging to the Keokuk group of the Sub-Carboniferous period, being an extension of that formation from the adjacent lead region of Missouri. The Cretaceous group, formerly called the Fort Hays group, is here recognized as that elsewhere known as the Fort Benton group, and is so named.

Prof. Mudge contributed also many papers on geological subjects (*e. g.*, "Cretaceous Forests and their Migrations," "Bison Latifrons in Kansas," "Geology of the Arkansas") to the annual meetings of the Kansas Academy of Science, but the publications above referred to give most definitely the results of his work and show the advancing knowledge of geology.

Since the death of Prof. Mudge the State Board of Agriculture has employed Prof. Orestes St. John as its Geologist. In the Biennial Report for 1881–2 he gives a very valuable treatise on the geology of the State. The subject is treated with reference to topography, stratigraphy, and economics. The surface formations (quaternary) are more fully discussed, and the drainage is well shown. The report

is accompanied by a set of sections and a contour map of the State and adjoining territory. The colored map showing areal development of formations shows advance in knowledge on that of Prof. Mudge in the location of the western limit of the permo-carboniferous formations south of the Arkansas river. Prof. St. John has also in the bulletins and a later report of the State Board contributed an increase of knowledge on the coal region of the southeastern counties, and a paper on the supply of water by artesian wells.

The State Board of Agriculture has in its reports printed many valuable papers on branches of Natural Science, Entomology, Pomology, etc., related to the material advancement of the State. A recent bulletin contained a paper on "The Water Supply of Western Kansas," geologically considered, by Prof. Hay, of Junction City, in which the newly-recognized Tertiary grit (Miocene—Loup Fork) is shown to be an important factor in the distribution and retention of water in the western half of the State.

In 1875 the State Legislature passed a law requiring that to hold the highest grade of certificate teachers of district schools should by examination show that they had at least an elementary knowledge of geology. Though this requirement has since been repealed, it gave an impetus to geological enthusiasm, and paleontological collections began to be made in many schools. By request of State Superintendent Fraser, a small work on Kansas geology was prepared by the late Prof. W. K. Kedzie, of the State Agricultural College. This was published in 1877. It was mainly based on the reports of Prof. Mudge, and recognizes in Kansas the following formations, viz.:

LOWER CARBONIFEROUS	Keokuk limestone.
UPPER CARBONIFEROUS	Lower coal measures. Upper coal measures. Permo-carboniferous.
CRETACEOUS	Dacotah. Niobrara.
TERTIARY	Pliocene.
POST TERTIARY	Drift. Bluff. Alluvial.

It will be seen that Prof. Mudge's provisionally-named Fort Hays group, afterwards recognized as the Benton, is omitted.

In 1868 the Kansas Natural History Society was organized. It has since become the Kansas Academy of Science. Its members have done original work in botany, entomology, ornithology, archæology, meteorology, mathematics, geology, and paleontology. The reports of its proceedings are printed by the State, under the title of "Transactions of the Kansas Academy of Science." Thus far, then, these reports are official; they are made at the cost of the State, as are those of the State Board of Agriculture, and they are increasing in value year by year, being frequently accompanied by lithographed plates. Prof. Mudge was the first president, and besides contributing many characteristic papers to the proceedings, his geological enthusiasm and genial nature enabled him to give a *geological bias* to the general work of the Academy, the impetus of which is yet felt. Besides those already mentioned, Prof. Mudge contributed many other papers to the Academy, and other members did service directly or indirectly bearing on geological science in Kansas. Joseph Savage, of Lawrence, has had papers on "The Yellow Marl," and the "Sink-Holes in Wabaunsee County." Erasmus Haworth has elaborated the geology of Cherokee county. Robert Hay, of Junction City, has described a small metaphorphic area in

Woodson county, in a paper entitled "The Igneous Rocks of Kansas," and contributed papers on "Fossil Wood" and "The Dacotah Formation." Professors Patrick, Kedzie, Failyer, Bailey, and Willard, have given analyses of minerals and mineral waters. In 1883 the Academy contributed to the expenses of an exploration in the Northwest by Mr. Hay, the results of which were published in the Transactions, under the title of "A Preliminary Report on the Geology of Norton County." In this report the tertiary deposits of the region examined were recognized as belonging to two epochs—the pliocene and miocene—separated by a period of erosion, the lower one being also shown to rest on eroded surfaces of the underlying cretaceous deposits. Papers read at the last meeting (November, 1885) of the Academy, (of which the Transactions are not yet published,) give discoveries south of the Arkansas, showing large development of Jura-triassic strata in Harper, Kingman, Barber, Comanche, and Clark counties, and traces of former extension of tertiary strata as far east as Wichita, and great extension of quaternary formations.

Paleontology has been advanced considerably by the collections of Kansas geologists. Prof. Mudge's name has been attached by eastern authorities, such as Meek and Lesquereux, to new species both faunal and floral. Prof. Mudge also discovered the tracks on the Osage flagstones; and he records in his report as State Geologist, tracks on the sandstones of central Kansas. Frank H. Snow, Professor of Natural History at the State University, and a valued helper of the Academy, has contributed among other papers "Notes," accompanied by a lithograph, on the "Dermal Covering of a Mosasaur," which is in the collection of the University. Professor Patrick reported on the protozoans contained in Kansas chalk. W. Wheeler has given notes on a fossil tusk. Mr. Silas Mason supplied a list of fossils found in Riley county (Permo-Carboniferous). Kansas Cretaceous and Tertiary fossils have by their number and importance served to bring those formations into notice, and eminent eastern paleontologists have not only examined Kansas fossils but employed collectors for long periods to obtain them. Prof. Mudge, Dr. S. W. Williston, and Mr. Charles Sternberg have sent many Mezozoic and Cenozoic fossils to Yale College and elsewhere. Mr. Silas Mason has sent the Philadelphia Academy of Science large quantities of fine specimens of the Dacotah and Carboniferous floras. Professors Meek, Cope, Marsh and Lesquereux have been here and personally examined the horizons which have yielded such abundant illustration of the ancient life. Dr. Hayden has also contributed to the definition of Kansas formations. The State reports of Illinois have been used by Professor St. John as media for describing Kansas paleontological phenomena.

The Kansas City *Review* has been used as a favorite medium for conveying scientific information by scientists of Missouri and Kansas. Professor Broadhead, of the Geological Survey of Missouri, has in its pages several times contributed information about Kansas geology. In one article he narrates an exploration in southern Kansas, in which he defines the western boundary of the coal measures in that region. It is remarkable that his line between the coal measures and the permian is a continuation of the line in northern Kansas given in Long's map, before referred to.

Reports and papers now awaiting publication will alter somewhat the geological map of the southwest of the State, and sections will indicate that there is now recognized an easterly dip in the west part of the State, which is not what was generally thought a few years ago. The following may be taken as the now known order of Kansas strata:

Lower Carboniferous, (Keokuk Limestone,) southeast corner of the State.

Coal measures.

Permo-carboniferous, across the State.

Juro-triassic, from 98° to 101° longitude, south of the Arkansas river.

Cretaceous — three groups, across the State.

Tertiary grit — Miocene, west half of State, mostly on the edge of high prairie and the upper slopes of valleys.

Tertiary marl — Pliocene, west half of the State, mostly on the high prairie land.

Quaternary — Drift, northeast part of State.

Quaternary — Champlain, in isolated areas.

Quaternary — Loess, in eastern half.

Quaternary — Alluvium.

Much remains to be done. The area of 81,000 square miles cannot be thoroughly explored in a quarter of a century by desultory efforts, however enthusiastic. Steady, consecutive work is needed. It is now known that the drift area contains true morainal deposits which await examination, and other Quaternary deposits are claiming the attention not yet given to them. Questions of dynamic geology — upheaval and erosion — faulting and flexure, are pressing forward, and they have all economic value which awaits expression.

In compiling the foregoing sketch, the following material has been used, viz.:

1. Kansas Statutes. Session Laws of 1864.
2. " " " " " 1865.
3. First Annual Report on the Geology of Kansas for 1864. B. F. Mudge. 1866.
4. Preliminary Report on the Geological Survey of Kansas for 1865. G. C. Swallow. 1866.
5. United States Geological and Geographical Surveys for 1875.
6. First Biennial Report. State Board of Agriculture. 1877–8.
7. Third " " " " " 1881–2.
8. Fourth " " " " " 1883–4.
9. Quarterly Reports. " " "
10. Transactions of Kansas Academy of Science. 1876.
11. " " " " 1877–8.
12. " " " " 1881–2.
13. " " " " 1883–4.
14. Newspaper reports of Academy meeting for 1885.
15. Agricultural Geology, by W. K. Kedzie. 1877.
16. Articles by Professors O. C. Marsh, E. D. Cope, Leo Lesquereux, and F. B. Meek, in United States Geological and Geographical Surveys, by Dr. Hayden.
17. Geological Survey of Illinois. Vol. VII. 1883.
18. Sundry articles in Kansas City Review.
19. " " in American Naturalist.
20. Works of Dana and LeConte.
21. The MS. of F. G. Adams on the Bibliography of Kansas Geology.

[NOTE.—Since the above was written, in June, 1886, the U. S. Geological Survey has printed topographical maps of a square degree in southeastern Kansas, the partial result of the two previous seasons' work by a geographical corps under the direction of Prof. Gannett, the chief topographer of the Survey, and the whole of the season of 1886 having been similarly employed. Topographical maps, on a scale of half an inch to a mile, with contour lines fifty feet apart, are in an advanced stage of preparation for the eastern third of the State.—Also, Prof. Hay was employed during the season of 1886 to work up the geology of the southeast of the State, and his report of a reconnoissance in southwestern Kansas, made in 1885, is now in the hands of the Government printer as a Bulletin of the U. S. Survey.—The new Biennial Report of the State Board of Agriculture (1885–6) has an article by Prof. St. John which shows advance in knowledge of the details of the geology of the southwest of the State. The same volume has an article on the Geology of the Natural Gas of Eastern Kansas, as one of the results of Prof. Hay's work in that region.—R. H.]

ATLANTIC *VS.* PACIFIC ELEVATIONS IN KANSAS.

BY H. V. HINCKLEY, B.S., M.AM.SOC.C.E., TOPEKA.

[This article is substantially a reproduction of one read before the American Society of Civil Engineers, March 3, 1886.]

Our meteorological records, the study of our climatology, and our astronomical observations and the general advancement of science, demand, in the interest of accuracy, a more thorough knowledge of our elevations above the sea. An astronomer about to observe the transit of Venus, asked of me the height of his point of observation, saying that it was necessary for his calculations that he have the elevation stated above mean tide within a possible limit of error of five feet. I gave him elevations from both oceans according to my own figures, (the two heights differing from each other less than three-quarters of an inch,) and stated to him that the highest authority on elevations (Henry Gannett, Ch. Geographer of the U. S. Geolog. Survey) would tell him that neither elevation was within thirteen feet of correct. My reason for this statement will appear near the close of this paper.

The Government has been constantly at work on elevations throughout the country, especially sites of signal stations and meteorological observations. The height of Pike's Peak has been determined several times by barometer and triangulation, and later by check levels to settle a discrepancy of a very few feet, and to obtain, with the greatest possible accuracy, the elevation of the signal station above mean tide; and yet to this day, neither the Coast Survey, the Geological Survey, nor the Signal Service, can tell from actual determination the difference between the mean tide elevations of the two oceans on the United States coasts, or whether any such difference exists. The determinations of the greater part of the elevations in the United States have been first by barometer, and afterward by railroad levels or other more reliable authorities. The inaccuracy of the barometer, even when all known corrections have been applied, and the careless and incorrect reports of elevations from the profiles of the railroads, have caused much annoyance in the geographical department of the Geological and Geographical Survey at Washington.

The "Lists of Elevations" collated by Mr. Gannett, and published in 1877 by the U. S. Geological Survey, contains, on page 20, a reference to the A. T. & S. F. R. R. levels, founded upon statements obtained from that road, and which reads as follows: "On account of the character of the leveling between Topeka and Kinsley, this line is valueless as a check." Corrections of 18 to 68 feet were made by Mr. Gannett upon the elevations, furnished from the profiles of different parts of the road. I first noticed this in 1882, and, believing that errors of such magnitude in location levels could hardly have been embodied in the construction-work without being detected by either leveler or locomotive, I determined to test the correctness of the levels upon the A. T. & S. F. R. R. by carefully searching for breaks in datum planes, making the proper corrections for all parts of the various lines, and obtaining such checks as might be obtainable from intersecting roads and reliable benches, in order to determine whether the discrepancies and necessary corrections reported back by the Government were due to the general unreliability of the railroad levels, or to improper reports to the Government officers of unadjusted elevations; and in order to avoid, if possible, a continued confusion and doubt as to elevations of prominent points, and, in fact, of nearly every station along the Santa Fé line.

Under authority from A. A. Robinson, Sec., V. P. and Ch. Engr., I have compiled a profile of the entire A. T. & S. F. system of roads, from the Missouri river to the Gulf of California, at a cost of over a thousand dollars. This profile gives the corrected elevation of every station on the line, being that of the top of rail at east end of depot

in each case where a depot exists; and the elevations have been carefully figured to a thousandth of a foot in all cases, not to indicate that the track is everywhere so true to its original grade, but in order that my results, and any work that may in future be based upon my results, may be correct to the extent of the information at my command. My elevations east of the Continental Divide I have figured from Atlantic "mean tide," and are based upon a United States bench on the face of the south abutment of the Hannibal & St. Joseph Railroad bridge, over the Missouri river, at Kansas City. The elevation of this bench was taken, 428.29 (St. Louis Directrix, by James T. Gardner, in "Elevations of Datum Points," 1875) +841.394 (furnished me by Wm. B. Knight, City Engineer of Kansas City, Nov. 2, 1882) =769.684. My elevations west of the Continental Divide are above Pacific "mean tide" at Guaymas, Sonora, Mexico, taken as 0.625 feet below Guaymas "mean high tide," (from data furnished by T. J. Seely, Asst. Gen. Manager Sonora Ry., Feb. 9, 1883.)

The following checks, numbered 1, 2, 6, and 8, were obtained before the completion of the profile, and the others are the result of later investigation:

CHECKS.

1. Elevation carried from Kansas City to Atchison via Topeka compares with elevation taken from U. S. bench at Atchison Union Depot, +0.006 of a foot. Length of circuit, 173 miles. Length of railroad levels, 116 miles.

2. Elevation carried from Kansas City to Emporia Junction compares with elevation carried from Kansas City via Topeka, North Topeka and Junction City, over the Union Pacific and Missouri Pacific railroads to Emporia Junction, +0.180 of a foot. Length of circuit, 196 miles.

3. Elevation carried from Kansas City via Albuquerque and the Atlantic & Pacific R. R. to the Colorado river compares with Southern Pacific elevation brought from San Francisco, (based upon Fort Point high-water datum, and corrected, —1.790 feet; per data furnished by the Signal observer at San Francisco, Oct. 22, 1883,) —2.040. Length of railroad levels, 2,115 miles.

4. Elevation carried from Kansas City via Albuquerque, Mojave and Yuma, over the Atlantic & Pacific and Southern Pacific roads to Port Ysabel, at the head of the Gulf of California, compares with mean tide at that point, —1.03 feet, (+2.80, S. P. reading at Port Ysabel per Geo. E. Gray, Ch. Engr., —2.04 per check No. 3, —1.79 S. P. correction also given in check No. 3.) Length of railroad levels, 2,149 miles.

5. Elevation at East Pueblo crossing of A. T. & S. F. R. R. and D. & R. G. Ry. compares with elevation carried from Kansas City to El Moro and thence over the D. & R. G. Ry. via South Pueblo, —0.580 of a foot. Length of railroad circuit—Pueblo, La Junta, El Moro, Pueblo—246 miles.

NOTE.—I have no less than six checks upon Pueblo via Denver, covering a range of 26 feet. The indefinite way in which these have been reported to me destroys my confidence in them all, especially as none of them agree with my results, while my check No. 5 proves the correctness of my results upon the Pueblo elevation within 7 inches. I must quote here from Gardner's "Elevations," (page 631): "I am satisfied that the important errors in our railroad and canal profiles are not so much due to imperfect instrumental work as to hasty and careless combination of the results." It would also be proper to state here that I have checked upon the St. Louis & San Francisco Railroad, at Augusta Crossing and North Wichita Junction, their elevations being carefully given to me by James Dun, Chief Engineer, and my results comparing with his at those two points, —7.212 and —7.882 respectively. Elevations of both roads being based upon the same elevation of St. Louis Directrix, and the results being therefore independent of the absolute height thereof. I should also state that Chief Engineer Perris, of the California Southern Railroad, has carefully reported to me two checks of his road upon the Southern Pacific Railroad, as follows, (Nos. 20 and 21:)

20. Elevation carried from San Diego over the California Southern Railroad to Waterman by location levels, compares with Southern Pacific elevation from San Francisco +1.801 feet.

21. Elevation carried from San Diego over the California Southern Railroad to Waterman by check levels, compares with Southern Pacific elevation from San Francisco +3.684.

6. Elevation at Deming compares with Southern Pacific elevation, corrected as in No. 3, —0.062 of a foot. Length of railroad levels, 2,347 miles.

7. Elevation from Deming carried via Southern Pacific Railroad and Yuma to Port Ysabel compares with mean tide at that point (2.80 —1.79 —0.062) +0.948 of a foot. Length of railroad levels, 1,685 miles.

8. Elevation at Continental Divide (about 40 miles west of Deming and upon a stretch of 173 miles of unconstructed line) compares with "mean tide" elevation brought from Guaymas, —3,390 feet. Length of railroad level, 1,657 miles.

9. Elevation at the Southern Pacific overhead crossing of the A. T. & S. F. R. R. near El Paso compares with the Southern Pacific elevation at the same point (brought from San Francisco and corrected as in No. 3,) +0.128 of a foot, (from data secured by S. P. R. R. during construction,) and +0.460 of a foot, (from data secured by A. T. & S. F. R. R. four years later.)

NOTE.—The A. T. & S. F. determination was merely as a second or double check, and the difference between the two checks (about 4 inches) I attribute to four years' settling of the overhead crossing trestle. For correct results, therefore, I use the first comparison in No. 9, and discard the second.

10. Elevation at Deming compares with elevation carried from Albuquerque over Atlantic & Pacific & Southern Pacific railroads via Mojave to Deming (2.04 —0.062) +1.978 feet. Length of circuit, 1,862 miles.

11. Elevation at Rincon compares with elevation carried from Rincon via Deming and El Paso crossing back to Rincon, +0.190 of a foot. Length of circuit, 218 miles.

I had thought I should be doing well if I secured a transcontinental check within 10 or even 20 feet, or if I secured a check upon any reliable bench east of the Continental Divide within 10 feet. The first, closest and most reliable check obtained was No. 7; and it was generally looked upon as a remarkable coincidence, if not possibly a "manufactured" check, and I little expected to have it so closely supported by the ten other checks above given. All the old field-note books and profiles were diligently searched for breaks, and all the checks here given are substantiated by documents on file in my office. Summarizing, first those lines which are all rail, or upon which level checks level, and assuming absolute accuracy in the U. S. levels between the Kansas City and Atchison benches, we have the following table of—

RAIL CIRCUIT CHECKS.

No.	From	Via	To	Miles.	Errors in feet.	Errors, feet per mile.	Errors, inches per mile.
1.....	Kansas City.....	Topeka.....	Atchison.....	116	0.006	0.00005	0.00060
2.....	Emporia Junc...	N. Topeka and Junction City	Emporia Junc...	196	0.180	0.00092	0.01104
5.....	Pueblo	La Junta and El Moro.....	Pueblo	246	0.580	0.00236	0.02832
10.....	Deming	Albuquerque and Mojave	Deming	1,862	1.978	0.00106	0.01272
11.....	Rincon.....	Deming and El Paso.....	Rincon.....	218	0.190	0.00087	0.01044

Next summarizing the checks furnished by the assumption that the mean tides of the two coasts have a common elevation, and that Gardner's Atlantic elevation of Kansas City as above stated is correct, the later levels of the Mississippi River Commission and Coast Survey to the contrary notwithstanding, and throwing check No. 8 out of the general results on account of the unreliability of 173 miles of unchecked preliminary mountain levels, we have the following table of tide checks:

TIDE CHECKS.

No.	From	Via	To	Miles.	Errors in feet.	Errors, feet per mile.	Errors, inches per mile.
3.....	Kansas City....	A. & P. R. R.....	San Francisco....	2,115	2.040	0.00096	0.01152
4.....	Kansas City....	A. & P. and S. P.,	Port Ysabel.....	2,150	1.030	0.00048	0.00576
6.....	Kansas City....	Deming.....	San Francisco....	2,847	0.062	0.00003	0.00036
7.....	Kansas City....	Deming.....	Port Ysabel.....	1,686	0.948	0.00056	0.00672
8.....	Kansas City....	Tombstone.....	Guaymas.....	1,657	3.390	.....	.....
9.....	Kansas City....	El Paso.....	San Francisco....	2,459	0.128	0.00005	0.00060

NOTE.—Lieut. Gardner, in his "Elevations of Datum Points," 1875, (pages 643, 644 and 653,) reports errors as follows:

(*a*) 9.9 feet, Portland to New Orleans via Chicago, 2,100 miles, or 0.0048 feet per mile.

(*b*) 2.44 feet from New York Bay to New Orleans via Chicago, 1,800 miles, or 0.0013 feet per mile.

(*c*) 4.61 feet, Raritan Bay to New Orleans via Chicago, 1,800 miles, or 0.0025 feet per mile.

(*d*) 25.0 feet, Portland to San Francisco via Chicago, 3,500 miles, or 0.0071 feet per mile.

(*e*) 26.0 feet, New Orleans to San Francisco via Kansas City and Denver, 3,200 miles, or 0.0081 feet per mile.

Mr. S. D. Mason, Principal Asst. Engr. N. P. R. R., under date of Nov. 19, 1885, reports an error of "about 4 feet," (not yet definitely determined,) from Lake Superior, at Duluth, to Commencement Bay, at Tacoma, 2,033 miles, or 0.00185 feet per mile. The correctness of my results within the limits of my stated errors is not corroborated by these errors reported from other roads, as they have no bearing upon the St. Louis Directrix or any of my elevations, and are given here merely for a comparison of errors per mile in levels.

By the close results which have been obtained I am convinced that the necessity for the excessive corrections applied by Mr. Gannett arose from the elevations reported to him not having been corrected for breaks in datum planes. I do not offer my results as evidence that railroad levels in mountainous regions are generally to be depended upon within a hundredth of an inch per mile, nor would I intimate that the close results over these particular circuits and check lines from the Missouri river to the Pacific ocean prove the correctness of the old elevation of St. Louis (428.29) and the Missouri river benches at Kansas City and Atchison, as stated by Gardner in 1875, from Atlantic tide points; but in view of the fact that the recent levels of the Coast Survey and Mississippi River Commission tend to lower the elevation of St. Louis and neighboring points 13 and 15 feet respectively, the results given in the second table above, and based upon Gardner's St. Louis datum, are of special interest at this time, for to reduce St. Louis 15 feet would be to make the "errors in feet" in my second table range from 13 to 19 feet.

By using the Atlantic mean tide benches established in the Missouri river valley twelve years ago and the most reliable line of railroad levels which I have at command, and which has but one break, I check from ocean to ocean (mean tide to mean tide) within three-quarters of an inch; and now come the Mississippi River Commission and Coast Survey with their "levels of precision" and say the old benches were too high by 15 and 13 feet respectively. I append Mr. Gannett's letter of Oct. 20, 1883:

DEPARTMENT OF THE INTERIOR, UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, Oct. 20, 1883.

Mr. H. V. Hinckley, Office Engineer A. T. & S. F. R. R.—DEAR SIR: I am in receipt this morning of your communication of the 12th, containing your list of carefully-determined elevations upon the line of your road. Allow me to thank you in the warmest possible terms for this favor, and to assure you that the fullest credit will be given for this valuable piece of work. I am very much puzzled about this change in the St. Louis Directrix, and the consequences it involves. There can be no mistake about the figures as I have received them from the Secretary of the Commission, and the change which this makes is corroborated by the corresponding changes in the heights of Cairo and other points below on the river, the heights of which were received from the Secretary of the Commission at the same time. On the other hand, the checks westward from Kansas City are thrown into confusion not only upon your road but upon other lines. Very truly yours,

HENRY GANNETT,
Chief Geographer U. S. G. S.

I have been unable, up to this time, to secure from our Mexico roads or from Nicaragua or Panama any reliable statement as to the comparative elevations of the two oceans, but I believe there can be no appreciable difference except it be local affected by contour of coast or possibly by winds and ocean streams. See letters from the Chief Geographer and Supt. C. & G. Survey, below:

DEPARTMENT OF THE INTERIOR, UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, April 18, 1885.

Mr. H. V. Hinckley, Office Engineer A. T. & S. F. R. R., Topeka, Kansas—DEAR SIR: If there is any difference in level between the Atlantic and Pacific oceans, it is too small to be indicated by levels of such a character as those run by our inter-oceanic canal expeditions. I have not learned anything concerning this point from the work now progressing upon the Isthmus of Panama. I feel, however, confident that the difference, if any, is very small. Very truly yours, HENRY GANNETT,
Chief Geographer U. S. G. S.

U. S. COAST AND GEODETIC SURVEY, WASHINGTON, June 26, 1885.

H. V. Hinckley, C. E., Topeka, Kansas—DEAR SIR: I have taken great interest in your important letter of the 23d, relating to the difference of level between the Atlantic and Pacific oceans. I trust that you will print your study in detail in the Journal of the American Society of Civil Engineers, and I will be very glad to print it likewise in the Coast Survey Report. The agreement of the several values is certainly unexpectedly close. I nevertheless do not think that the difference of the mean level of the oceans will be found so large by accurate operations. That which you give for San Francisco would, of course, be extremely acceptable. I do not think there can be any such thing as rotational difference of level between the two oceans, but the mean value of *what we are able to observe by means of spirit or water levels is the resultant of the constant forces, and, whatever may be the figure of equilibrium, it is just that which the level indicates.* When we observe a difference, then, it must be owing to dynamic effects of currents and winds. I have thus found the level of the Gulf of Mexico, in the neighborhood of the Balize, to be about forty (40) inches higher than that of the Atlantic ocean at Sandy Hook. That such an elevation must exist is plain enough, from the fact that the water runs from the Gulf of Mexico into the Atlantic ocean; but how much it is, is a question that must be solved by accurate leveling, and a verification is still in progress.

We have not yet extended our line of levels of precision to the Pacific ocean, but will proceed with it in the autumn. I do not know the difference of level between the two oceans at any point. I have always understood that the levels for the Panama Railroad showed that there was no appreciable difference between mean tides. . . . I shall be glad to hear from you again on the subject.

Yours truly, J. E. HILGARD, *Supt. U. S. C. & G. S.*

So that for the present I shall contend that my elevations are correct, and that the corrections of Mr. Gannett, in his 1884 edition of "Dictionary of Elevations," upon the A. T. & S. F. system, are unmerited, even though his precise information to the contrary warrants, on his part, the corrections he now makes. Therefore the question of sea elevations in Kansas must remain "at sea" to the extent of from 1 to 15 feet, or even more, depending on the locality, until the "levels of precision" shall cross the continent, or perhaps till I may earlier obtain checks enough from Texas and Mexico ports to prove the correctness of my apparently very correct results.

NATURAL GAS IN EASTERN KANSAS.

BY ROBERT HAY, U.S.G.S.

[N. B.—The paper with this title which was read at the Emporia meeting was much longer than the following. The introductory part, relating to the development of natural gas in Pennsylvania and elsewhere, has been almost altogether omitted, the more scientific part remodeled, and some additional facts given which became known only a little while before going to press. The paper as read at Emporia appears almost in its entirety in the Fifth Biennial Report of the State Board of Agriculture, whose widespread distribution will bring it within the reach of nearly all the citizens of the State.]

A single company at Pittsburgh, Pa., has a capital of five million dollars invested in procuring and distributing for use the new fuel named usually natural gas. Altogether, the natural gas companies of Pennsylvania employ an aggregate capital of more than twenty millions of dollars. At Wheeling in West Virginia, Findlay in

Hancock county, Ohio, and other places, the work done by means of natural gas is enormous, and is increasing. This gas, like petroleum or rock oil, comes from the bowels of the earth. It may be properly named *rock gas*. It is obtained from drilled wells, some of which are over three thousand feet in depth. The strata which yield the gas are more or less porous, like those which yield the rock oil. They are mostly sandstones, and as the oil beds are known as "oil sands," so those which yield gas are known as "gas sands." The porous sandstones, some of which are coarse-grained, are not the sources but only the reservoirs of the fluids they contain. The source is the decomposition of organic matter — mainly vegetable — with which certain other formations are charged to a greater or less extent. These other formations are the dark-colored shales, and the so-called "black slate," and the seams of coal, which under the conditions of their deposit and existence, including the enormous pressure of hundreds or thousands of feet of superincumbent rocks, give out their fluids — water, oil, and gas — to the porous beds above or below them. Gas and oil are, as would be expected, often in a porous rock *above* the shale-bed source. Water is always as low as it can get. The water mostly associated with oil and gas is salt water. Oil wells usually have some gas; gas and brine wells have some oil.

The term "gas sand" is used so commonly that it has become the equivalent of the more general term "gas rock," and as such has been used where the containing bed is not sandstone but limestone. In Ohio the Trenton limestone of the Lower Silurian age has at a depth of 1,200 feet yielded gas and oil. If the rock is porous and has an impervious covering of clay-shale or clay, it will hold these fluids. The writer has treated a small piece of compact Permian limestone thus: It was dried about to what it would be by outdoor exposure in dry weather. After carefully weighing it, it was immersed for twenty-four hours in coal oil — the ordinary lamp oil of commerce. Taken out, it was allowed to drain for an hour, and the wetness was all wiped off. It was then carefully re-weighed. The result was as follows:

Weight *before* immersion, 103.5 drams.

Weight *after* immersion, 104.5 drams.

This shows a quantity of oil absorbed in one day under ordinary atmospheric pressure, amounting to nearly *one per cent.* of the total weight of the stone. The writer has seen both sandstones and limestones much more highly charged with oil than this. When an impervious covering is over such porous rock, and hundreds or thousands of feet of superincumbent rock formations give their enormous pressure to force the gas or oil into the rock pores as fast as it is formed in nature's laboratory, such porous rocks become vast storehouses of these valuable fuels. As we have said, the two fluids are usually found together, though one or the other may preponderate to such a degree as to cause the other to be but slightly regarded. But we shall now speak more definitely of *rock gas*.

The geological horizons at which rock gas has been found in Pennsylvania, West Virginia and Ohio are in the Lower Coal Measures, and thence downward to the Lower Silurian. The upper horizons are below the Pittsburgh Coal; an important intermediate horizon is the Berea Grit, in the Waverley Series, and the lowest is the Trenton Limestone.

The force of the gas when the drill of the prospecter has tapped the porous reservoir is sometimes such as to throw out the heavy tools used, and when ignited, to send a flame forty feet high. The pressures measured, and estimated where measurement was impossible, show the equivalents of from fifteen to fifty atmospheres. These great pressures have caused much waste of gas, much leakage from pipe joints, and consequent danger from explosions. On the other hand, the great pressures have made it possible to pipe the gas to great distances, and the danger has stimulated invention, so that perfectly tight joints are now made. Pittsburgh receives

gas from distances of from twelve to thirty miles, and Buffalo has just begun to have a supply from a distance of ninety miles.

In Miami county, Kansas, small quantities of oil have been seen in springs and wells from the date of the earliest settlements, and borings have been made from 1862 to the present time. It was not, however, till 1883 that a strong flow of gas was obtained. Now the Paola Gas Company, of which B. Miller, Esq., is president, has drilled four wells, of which three are now yielding a steady supply of *rock gas*. These wells are situate on the Westfall farm, N.E. quarter of section 16, T. 17, R. 24, seven miles east of the city of Paola. They substantially have the same level at the surface, and reach the *gas sand*, which here is a sandstone, at a depth of three hundred feet. One of the wells pierces this sand, and shows its thickness to be 35 feet, and above and below it are dark-colored beds, which, being laminated and jointed in their structure, are by the miners called "slates." The gas is piped seven and a half miles into the city of Paola, where it is used as fuel to steam engines, bakers' ovens, heating-stoves, and also to some extent as an illuminant in the stores of the city. At two of the wells the pressure of the gas is 66 lbs. to the square inch, at the other well it is under fifty.

Within three miles of the Westfall wells, at the small town of Louisburg, a well 325 feet deep gives a supply of gas which is utilized for heating and lighting Gunsolus's Hotel. Another company is drilling nearer Paola.

At Wyandotte not less than six wells have been drilled, which yield gas and some oil. They give the gas all apparently from the same horizon, which is about 340 feet below the level of the Kaw bottom. Unfortunately, some of the records of these drillings have been lost, and others are not available. The gas of three of these wells, owned by Mr. Ryas and Messrs. Northrop, is being used for heating steam boilers, and it is not improbable that gas from these sources and new wells will be much more extensively used. Over the border, in Kansas City, Mo., a number of wells are yielding gas which is being utilized both as an illuminant and for fuel in dwelling houses, by Messrs. Tobener and Dr. Ridge, and on the outskirts of the city by Mr. J. N. Dietz for burning lime. The wells at Wyandotte and Kansas City form one group, but unfortunately the drill records of none of those utilizing the gas are available for a proper comparison. The pressure from the Ryas (brickyard) well is 150 lbs. to the inch, and it displaces ninety per cent. of the coal formerly used for an engine of forty horse power.

In Linn county, about two miles east of LaCygne, gas has been issuing from the ground from a period "beyond which the memory of man runneth not back to the contrary." It is not marsh gas, but rock gas, and around its flame Indians have had their assemblies. Through the enterprise of Mr. T. McCarthy, who has leased the land, a well has been bored 180 feet deep, and a continuous supply of gas at a considerable pressure is now blowing off. Owing to lack of capital this fine supply is not being utilized. A mineral well 125 feet deep, at Mound City, owned by Mr. T. Ellwood Smith, yields a steady but not very copious supply of gas. Another well, owned by Mr. E. M. Adams, of greater depth, also yields gas, which it is intended to use at an early date. At Pleasanton and Blue Mound borings have been made, with no remunerative result yet.

In Crawford county a small quantity of gas was found at a depth of 173 feet, in the mineral well owned by the city of Girard. At Pittsburg a larger supply is being obtained, at a depth of 163 feet, and will be immediately utilized. At a much higher horizon, at a depth of 45 feet, in the northwest of the county, some oil and a bubbling as of gas has been found in a well east of Hepler.

In Labette county borings have been made near Parsons without result, but at Mound Valley there is a well 700 feet deep which yields gas at depths of 203 and 449

feet. The lower depth gives the strongest gas. It is of such force and volume as to raise the salt water, which enters at 277 feet, up to the surface, so that it is a flowing well. Owing to doubts relating to the title to the land, this supply is being allowed to run to waste.

In Allen county the well-known mineral well at Iola has always yielded some gas, which at times has been utilized. It enters with salt water in a crevice of 20 inches deep, with black bituminous shale above and below, at a depth of 625 feet. In the same county, north by east from Moran, unused gas is blowing off from a well one hundred feet deep, in a valley drained by the headwaters of the Little Osage.

Some gas was found in the deep well at Independence, in Montgomery county. At near Liberty, in the same county, a shaft sunk for coal gives off from a black shale, at a depth of 98 feet, a gas which from its odor would be called coal gas.

In Bourbon county, on the banks of the Marmaton river, on the Stewart farm just southwest of the city of Fort Scott, gas has been known to escape from the ground for more than a quarter of a century. Now, the Economy Fuel Company (Major Knapp, manager) has leased the land, and drilled five wells. Three of these are yielding a strong supply, which appears to have about the pressure and qualities of the Paola gas. It is piped to the town through six-inch mains, and, as one of the wells supplies a fair illuminant, it is used both for heating and lighting dwelling houses, the principal hotels, the street-car barn, and many other places. With other wells judiciously located, there can be no doubt but that the supply of this gas will long be an important factor in the progress of the rising city of Fort Scott. The facts, that the gas has been escaping for years, and that the pressure is not nearly so great as in the eastern States, suggest that the supply is likely to be permanent. This is probably true at Paola, also, and more certainly at LaCygne.

Five miles west of Fort Scott, gas is bubbling in a well about 70 feet deep. In the eastern part of the city itself the same is occurring in a well 100 feet in depth. East-northeast from Fort Scott, seven miles north of Deerfield, in Vernon county, Mo., a similar shallow well gives out gas. At other places on each side of the State line, small quantities of gas have been thus observed, and also of oil.

There is now much activity in prospecting for gas at places where it has already been found, and at other places removed from the belt when its presence is assured. Among the latter places may be mentioned Quenemo, Ottawa, and Wichita. That it may possibly be found at some places not yet tested, will be seen from a consideration of the geology of the localities where the experimental drillings have been successful.

The rock gas obtained thus far in Kansas belongs geologically to the lower part of the Lower Coal Measures. Besides the gas wells at Fort Scott, there have been made four other borings at that place, the records of which have been preserved. These four go to greater depths than the gas wells. They are: The Brickley well, south of the city; the Walburn well, near the northeast corner; the Point well, and the artesian well. About the city the Marmaton valley and several smaller ravines are very steep and show ledges of rock. Going east, much erosion has laid bare successive formations. From an examination of these exposures, and a study of the drill records of the well-borings, the geology of the rock gas of this region can be made out fairly well. In the higher parts of the city a coarse fossiliferous limestone is found, in layers of from four to eight inches thick, with a total thickness about the city of from five to fifteen feet. This is followed by formations thus:

1. The layer limestone, (average) 10 feet.
2. Black slate, including a thin coal seam, 6 feet.
3. Heavy bed of concretionary hydraulic limestone, called locally "the cement rock," 5 feet.

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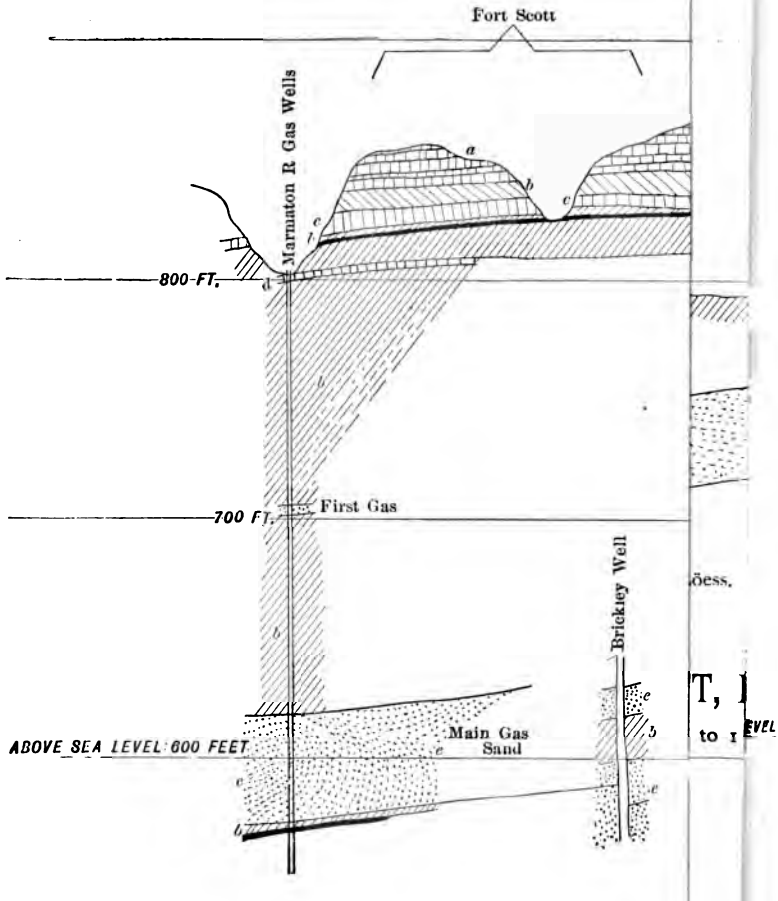

Fort Scott
Marmaton R Gas Wells
800-FT.
700 FT.
First Gas
Brickley Well
Main Gas Sand
ABOVE SEA LEVEL 600 FEET

4. "Slate," 2 to 8 feet.
5. Fort Scott coal, 18 inches to 2 feet.
6. Shales, arenaceous and argillaceous, about 50 feet.
7. Limestone, dark, 2 to 3 feet.
8. Shales, with occasional hard, thin beds of sandstone and limestone, 175 feet.
9. Sandstone, MAIN GAS SAND, 42 feet.

A thin "gas sand" is met with about midway between 7 and 9, and gas comes off coal or slate some forty feet below 9. "Black slate" and thin coal are immediately beneath the main gas sand. In the Brickley well the sandstone includes an intercalation of thirty feet of shale, and gives a much greater total thickness. The *gas sand* is about 245 feet below the "cement" rock, which is a very conspicuous feature in the topography of the district. (See geological section.)

Proceeding east from Fort Scott, the layer limestone, thickening considerably to the eastern limit of the city, is rapidly eroded and totally disappears about the region of the State line; the "cement" rock fails not far beyond, and shales are the outcrop of ravines as far as Drywood creek, on the east of which a sandstone shows itself, with a thin coal seam at the base. Around Nevada, which is much higher than the mouth of Drywood, this sandstone has great development, in places reaching over fifty feet thick. This is the formation which the Missouri geologists have named the Clear Creek Sandstone. In many places it is redolent of oil. The upper surface of this sandstone in Nevada is about fifty feet higher than the layer limestone at Fort Scott, but at its outcrop on Drywood creek it is fully fifty feet below that limestone. Proceeding west, buried under shales, it yields the gas in the shallow well north of Deerfield; and buried still further, it becomes the MAIN GAS SAND of Fort Scott. An examination of the section on the opposite page will make this easily understood, and an understanding of this will make the prospecting for gas in that region more a matter of certainty than without such understanding. A *complete* examination of the Paola gas region has not yet been made, but the tendency of the evidence so far is toward assuming the main gas sand there to belong to the same Clear Creek horizon. The tendency is also toward regarding the Pittsburg (Crawford county) gas as from the same sandstone; and the gas sand at Mound Valley is from very nearly the same horizon.

The two shallow wells in and near Fort Scott yield their gas from shale, probably locally arenaceous, not far below the cement bed.

West of Fort Scott, and stretching from north to south of Bourbon county, is a sandstone plateau. Its horizon is immediately above the layer limestone before mentioned, which in its wide extension develops great thickness (40 to 60 feet) as the Pawnee Limestone. The sandstone plateau yields valuable flagstones at Gilfillan, Redfield, and some miles east of Porterville, and also just over the line in Crawford county, south of Hyattville. These flagstones are frequently bituminous, and it is this sandstone, under cover of limestone and shale, that yields the oil on Mr. Pease's farm east of Hepler. It is a still higher sandstone under cover which yields the gas north by east of Moran, in Allen county.

In prospecting for oil and gas in Pennsylvania, theories as to the geological structure have been used to work from. The summit of an unbroken anticlinal slope would appear to promise the best position for a reservoir of gas in any suitable stratum, and it would appear that the bottom of a synclinal slope would be apt to have more water than gas or oil. Though exceptions to this rule are found, it may be taken for granted that it is true where other conditions do not modify the general structure. In Kansas, no pronounced anticlinals have yet been observed, though it cannot be doubted that there are well-defined synclinals, though of but moderate depression. All the principal gas wells are in valleys. Those at Fort Scott and Wyandotte are in

the most important valleys of their respective regions—valleys whose erosion long antedates the Glacial epoch. It would appear that these valleys represent slight synclinal folds, and that gas with less water may well be be expected further from their median regions. The main structural fact of the gas region of Kansas is the steady monoclinal dip to the west and north. This varies in amount; hence there are gentle local anticlines and synclines, but scarcely enough to alter the effect of the general monoclinal dip. This dip is fairly represented as to its westing in the section before given. It appears to be more than geologists have been prepared for, but it certainly decreases in amount in Allen county. If the *amount of the dip*, together with *variation of dip*, in local anticlinals or synclinals, plays any greater part in the supply of gas, then greater supplies will not probably be obtained much further west. It remains, however, to be noted, that in the valley of Fall river there are very decided changes of dip, whose limits have not been defined; and the wide region between the Marmaton, the Kaw and the Arkansas rivers needs much more examination before an opinion adverse to the occurrence of gas could be sustained—especially as it is known that dark, even black shales, and many sandstones, occur at higher horizons, which, dipping west, become sufficiently buried beneath shales and limestones; and an arenaceous limestone in Woodson county is heavily charged with oil.

It is probable that the Fort Scott oil well (Walburn's) obtains its supplies from the very highest beds of the subcarboniferous formations, probably Keokuk limestone, from 400 to 440 feet deep. This suggests that shales and sandstones at greater depths may yield the fluid fuels. According to Prof. St. John, the Silurian rocks are pierced by the deep wells at Pittsburg and Girard, and this would appear to be the same in the Brickley well at Fort Scott, whose total depth is 996 feet. Properly exploited, there may yet from deeper wells than the Brickley, be taken large supplies of gas or oil.

[N. B.—Small quantities of gas have been observed in Mitchell, Dickinson and Washington counties, and it is not improbable the Cretaceous and Lignitic formations may yield some supplies in central and western Kansas.—As this goes to press, another well at Paola yields gas at much higher pressure. It was tested to 105 lbs. to the square inch, but leakage prevented its full power being reached.—R. H.]

MISCELLANEOUS CHEMICAL NOTES.

BY PROF. E. H. S. BAILEY, LAWRENCE, KANSAS.

I.

ON THE PRESENCE OF BARIUM, STRONTIUM AND LITHIUM IN THE MINERAL WATERS OF KANSAS.

At a former meeting of the Academy, attention was called to the occurrence of Bromine and Iodine in our mineral waters, and the author predicted that other comparatively rare elements might be found. Prof. Mayberry reports the presence of Lithium in many of the wells of Cleveland, and suggests that greater care be exercised in testing for rare elements.* The water from a well in Miami county, Kansas, has been recently examined. It proved to be a saline well containing over 300 grains of solid matter per gallon. It was especially interesting since it contained a relatively large amount of lithium, with appreciable quanties of strontium, and of borax.

II.

MINERAL OIL FROM FORT SCOTT.

A sample of mineral oil from a well 431 feet deep, at Fort Scott, has been examined in the State University laboratory. The well is said to yield four barrels a

*American Association for the Advancement of Science. Buffalo. 1886.

day. The oil is quite similar in appearance to the Wyandotte oil, an analysis of which is published in the Fourth Quarterly Report of the Kansas Board of Agriculture (1885). In the examination of the Fort Scott oil, it was heated to 600° F., when 50–60 per cent. of a clear distillate was obtained. This is excellent as a lubricating oil, and burns with a smoky flame, by the use of a wick. The fact that it does not get solid except at a very low temperature, adds to its value as a lubricant. The original oil has also been used for the same purpose, with excellent success. It has a specific gravity of .922, and a flash point of 385° F. With petroleum at its present price, it is probably cheaper to buy lubricating oils than to manufacture them; but this oil may be of commercial importance in the future.

III.

ELLSWORTH COUNTY MINERAL WATERS.

A remarkably pure water from a point about seven miles west of Brookville has been examined. It is clear, and of excellent color and agreeable taste. It contains only 8.097 grains of solid matter per gallon. This is chiefly bicarbonate of lime, sulphate of lime, and chloride of sodium, with traces of silica, alumina, and bicarbonate of magnesia.

Another water, from a well some distance southwest of Brookville, proves to be a strong sulphur water. It is clear and limpid at first, but after a time deposits sulphur, and probably a compound of sulphur and iron. The water contains much magnesia, existing probably as chloride; iron, probably as chloride; calcium, as sulphate and sulphide; salt; free sulphuretted hydrogen gas, and silica. This may be mentioned as a water of considerable interest, and quite likely to be of value medicinally.

ON SOME KANSAS MINERAL WATERS.

BY G. H. FAILYER AND J. T. WILLARD.

To put them in permanent form for reference and comparison, we present the results of the analyses during the past year, of some mineral waters of this State.

No. 1 is a water from a spring near Omio, Jewell county. No. 2 from a spring five miles west of White Rock, Jewell county. No. 3 from a well near Stotler, Lyon county. No. 4 from a well at Columbus, Cherokee county:

NO. 1.

Substance.	*Grams per litre.*	*Grains per U. S. gallon.*
Potassium Oxide	.3406	19.9038
Sodium Oxide	.2509	14.6619
Lithium Oxide	.0115	.6510
Calcium Oxide	.6654	38.8842
Magnesium Oxide	1.1892	69.4938
Alumina	.1940	11.3368
Ferrous Oxide	trace.	trace.
Sulphuric Acid (SO_3)	4.2200	246.6058
Chlorine	.1491	8.7130
Boracic Acid (B_2O_3)	.0039	.2279
Silica	.0862	5.0375
No carbonates present.		

NO. 2.

Substance.	Grams per litre.	Grains per U. S. gallon.
Potassium Oxide	.13438	7.83677
Sodium Oxide	.17780	10.36894
Lithium Oxide	.00300	.17495
Calcium Oxide (as bicarbonate)	.23256	13.56143
Calcium Oxide (not as bicarbonate)	.54838	31.98043
Magnesium Oxide (as bicarbonate)	trace.	trace.
Magnesium Oxide (not as bicarbonate)	.76036	44.34268
Ferrous Oxide (as bicarbonate)	.01197	.69807
Sulphuric Acid (SO_3)	2.64284	154.12514
Chlorine	.02113	1.23227
Phosphoric Acid (P_2O_5)	.00024	.01400
Boric Acid	trace.	trace.
Silica	.02098	1.22351
Carbonic Acid present, but not determined.		

NO. 3.

Substance.	Grams per litre.	Grains per U. S. gallon.
Potassium Oxide	.06687	3.89972
Sodium Oxide	.13068	7.63266
Calcium Oxide (as bicarbonate)	trace.	trace.
Calcium Oxide (not as bicarbonate)	.29865	17.41667
Magnesium Oxide (not as bicarbonate)	.09341	5.44748
Ferrous Oxide (as bicarbonate)	.04536	2.64580
Sulphuric Acid, (SO_3)	.78970	46.05372
Chlorine	.01690	.98557
Phosphoric Acid (P_2O_5)	.00039	.02275
Silica	.03320	1.93616
Carbonic Acid not determined.		

NO. 4.

Substance.	Grams per litre.	Grains per U. S. gallon.
Potassium Oxide	.00419	.24434
Sodium Oxide (as bicarbonate)	.13389	7.80796
Sodium Oxide (not as bicarbonate)	.02123	1.23807
Lithium Oxide	.00010	.00594
Strontium Oxide	trace.	trace.
Calcium Oxide (as bicarbonate)	.05740	3.34745
Calcium Oxide (not as bicarbonate)	.00336	.19571
Magnesium Oxide (as bicarbonate)	.02605	1.51936
Magnesium Oxide (not as bicarbonate)	.01080	.62962
Alumina	trace.	trace.
Manganous Oxide (as bicarbonate)	.00080	.01647
Ferrous Oxide (as bicarbonate)	.00068	.03948
Sulphuric Acid (SO_3)	.01200	.69982
Chlorine	.03550	2.07052
Thiosulphuric Acid (hyposulphurous acid, S_2O_2)	.00720	.41989
Hydrogen Sulphide (sulphuretted hydrogen)	.01105	.64441
Silica	.00670	.39073
Sulphur in suspension and free Carbonic Acid, not determined.		

The Hydrogen Sulphide is equal to 7.27 cc. per litre, or 1.68 cu. in. per gallon. No other sulphides were present.

LOCO WEED.

(Astragalus mollissimus; Nat. Ord. Leguminosæ.)

BY L. E. SAYRE, PH.G.,
Kansas State University, Department of Pharmacy.

The plant commonly known as Loco or Crazy Weed has for many years excited much curiosity, as being one which produces upon animals who feed upon it very peculiar and sometimes alarming effects. Indeed, it is said by ranchmen to cause many of the heaviest losses among their cattle and horses.

With a view of gathering some statistics concerning the effects of the weed upon animal life, and the extent of loss therefrom, I visited, in January last, certain parts of New Mexico and Colorado, and since the meeting of the Kansas Academy of Science* have made a special trip for the same purpose, visiting more especially the southwestern portion of Kansas, from Harper to Meade counties. The latter trip was occasioned by Mr. Robert E. Steele, on the "Crooked L" ranch at Meade Center, who wrote he had a locoed cow which he would place at my disposal for examination if I would take the journey to his ranch.

The plant begins to appear at about Medicine Lodge, and to extend southwesterly into the Indian Territory and northwesterly through the State of Kansas. At Dodge City it was found growing abundantly in spots, although no locoed animals could be found or heard of thereabouts. Ranchmen say they have not been so much troubled with it in recent years, but scores had lost heavily from it in years past. It was ascertained from what appears to be reliable authority, that about 500 animals have been lost in Meade county during the past five years from the effects of this weed, though occasionally a person was met with who firmly asserted that the plant in question did *not* cause the so-called loco disease. A butcher in Grenada, Colorado, who had been interested in raising cattle and horses, and seemed to be quite intelligent in his subject, most positively stated that "he did not believe one word of all that was said about the Crazy weed. He had read and heard a good deal, but he had yet to see an animal becoming affected by loco. He had pastured right in it, and never lost one animal." A number of others gave like testimony. It would be impossible in the brief space of this article to give the various and sometimes conflicting statements concerning this weed. Evidently there has been a lack of accurate and skillful observation in the matter. The great majority report that the plant is truly named, as it makes the animals not only crazy, but is sure to kill them eventually. Dr. P. Harding, of Dodge City, a veterinary surgeon, stated that at one time he was dealing quite extensively in horses, and had lost a number from what he believed to be the effect of loco. In order to satisfy himself, he performed two experiments upon horses, with the weed; the first experiment being in the field, and the next in the barn. In the field he pastured two horses, both horses having a taste for loco. One of the horses found abundance of the plant in his pasture; the other horse found *none*, because it had been carefully removed from his portion of the field. The first horse died in the pasture; the second recovered from the previous feeding. In the barn he also placed two horses similarly affected, and fed one with dried loco, the other with clean hay. The first died and the other recovered.

The following summary of the effect of loco is based upon personal inquiry among ranchmen. The animal unaccustomed to the weed will not touch it as long as good feed is to be had, but after once partaking of it — driven to it in early spring

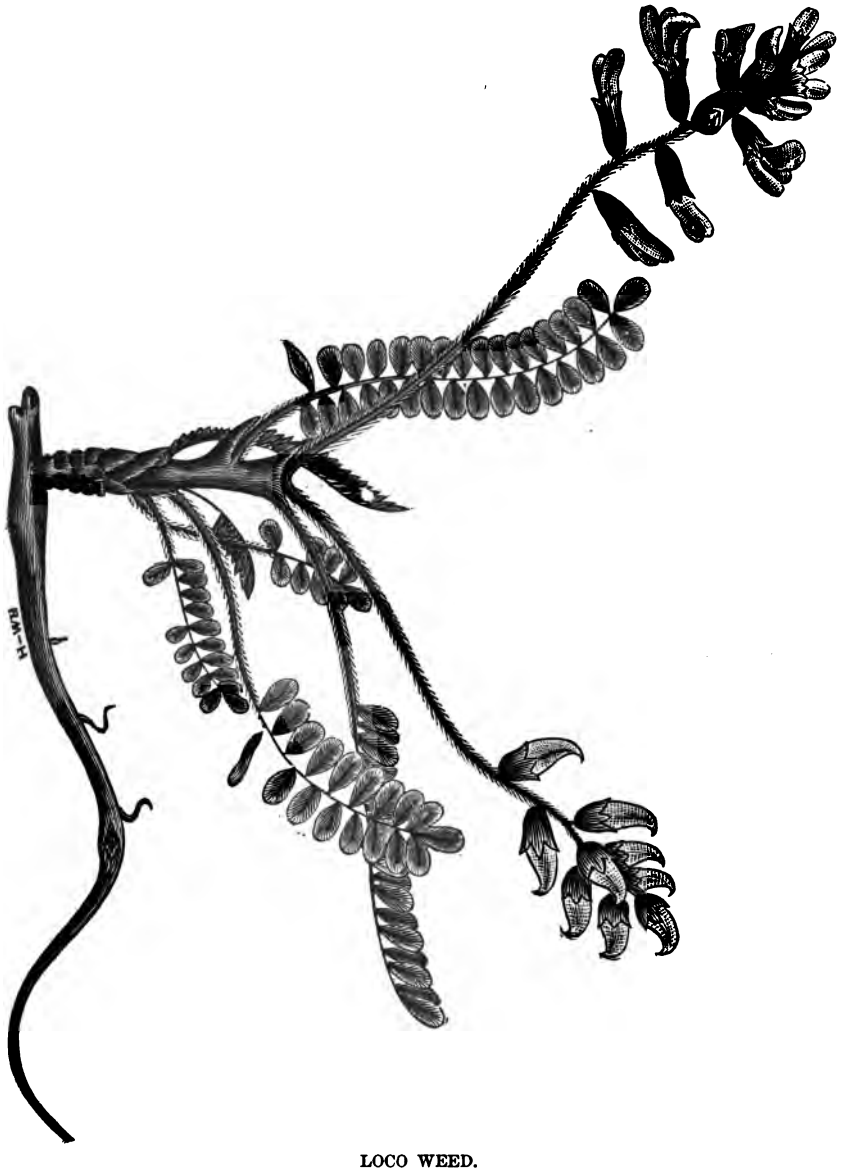
*The present paper is a revision of the one read at the last meeting of the Kansas Academy of Science, including the recent researches.

by the want of green vegetation — soon comes to prefer it to any other food, and finally refuses any other, leaves the herd and wildly searches for loco. The first effect upon the animal is hallucination. When led or ridden up to some trifling obstruction, such as a bar or a rope lying in the road, he stops short, and if urged on leaps over it as if it were a rail fence four feet high. Seemingly the optic nerve is affected; all sense of distance and dimension seems to be lost; a barn near at hand is to him afar off, and one a mile away near by. He will go headlong against a barn or a rock, or over a precipice, as if he were totally blind. The animal will, perhaps, let one get close to him, then suddenly and wildly run away at full speed and as suddenly stop, turn around, and it may be, come right back, stop short, stare, "and act like mad."

Mr. Wm. Smith, in the employ of Bollinger & Schlupp, ranchmen, seventeen miles south of Kiowa; Mr. D. R. Streeter, upon the "Z & Z" ranch, near Kiowa; and Mr. Steele, above referred to, are all quite familiar with the symptoms, and agree in every prominent particular concerning them. Mr. Steele gives as one of the prominent characteristics of the disease, "a stony stare." "If a sharp, quick motion is made before the animal's eyes, such as throwing up of the arms suddenly, it is likely to fall to the ground in apparent fright, as though not able to control its muscles." Sometimes a horse is seized as with a mania, in which he is quite uncontrollable and dangerous. He rears, even to falling backward, runs, or gives several successive leaps forward, and generally falls. His eyes are rolled upward until the whites can only be seen, which are strongly injected, and since he can see nothing is as apt to leap toward a wall or a man as in any other direction. Anything that excites him appears to induce such fits, which are perhaps more apt to occur in crossing water than elsewhere, and the animal sometimes falls so exhausted as to drown in water not over two feet deep. He loses flesh from the first, and presents the appearance of a skeleton. Nutritive energy seems to be paralyzed. In the last stage he only goes from loco to water and back. His gait is feeble and uncertain; eyes sunken, flat and glassy; his coat rough and lusterless, and in general the animal seems to suffer from starvation and constant excitement of the nervous system. Sometimes also he appears to experience acute pain, causing him to run from place to place, paw and roll until he falls, and then dies in a few moments. A correspondent from Texas states "he cannot tell when a horse is 'locoed' until he drives him very hard. After becoming heated he begins to be excited, and then the peculiar effect of loco appears."

There are two plants known as crazy weed, common in Kansas, Colorado, and New Mexico — the *Astragalus mollissimus*, and *Oxytropis Lamberti*, both belonging to the natural order Leguminosæ. E. A. Popenoe, Manhattan, states he has received from different parts, as specimens of crazy weed, beside the above, the following: *Malvastrum coccineum*, *Sophora sericea*, and *Amarantus albus;* but the writer has found from personal investigation that the farmers of our own and adjacent States mean by this title, "crazy weed," one or other of the two species above mentioned. Both the Astragalus and Oxytropis are rather attractive plants, and keep their color all winter.

The Astragalus grows on high ground and rather dry soil which is also gravelly and sandy. It blooms about June, and bears a bright-colored flower, rather attractive in its appearance. There are a great many stalks proceeding from the base. These stalks are reclining toward the base and erect and recurved above; subcaulescent, with soft, silky, villous pubescence. The leaflets usually in pairs, except the upper one (composed of from ten to twenty pairs) are somewhat densely clothed with soft, silky hairs. The flower stalk is usually longer than the leaf stalk, naked below, scape-



LOCO WEED.

like, bearing a rather thick spike of flowers, which have the general structure of the Leguminosæ.

CHEMICAL EXAMINATION.

In pulverizing the leaflets, the first portion which passes through the sieve consists almost wholly of the fine hairs which cause the pubescence to the structure. These hairs seem to constitute about one-third of the weight and over one-half of the bulk of the powder. From its light and spongy structure it is difficult to pulverize; the dust arising during the operation is irritating to the mucous membrane

—not from irritating principle residing in the plant, but from the immense quantity of broken, sharp-pointed hairs carried up with it. The light, fluffy character is remarkable, being one-tenth lighter than powdered senna.

PRELIMINARY EXAMINATION.

The air-dried powder was subjected to a temperature of 110° C., until it ceased to lose weight. The powder was found by this process to contain 10 per cent. of moisture. It was then incinerated in a platurium crucible, and yielded 12.01 per cent. of ash. The ash yielded to water 25 per cent. of soluble material, and to hydrochloric acid 50.6 per cent., the residue being largely silica. A qualitative analysis of the ash gave the following bases: CaO, K_2O, MgO, Al_2O_3, Fe_2O_3; and the following acid radicals: SO_3, Cl, P_2O_5, Co_2, and SiO_2.

The powdered drug yielded to water acidulated with hydrochloric acid 30.52 per cent., the solution evidently containing sugar, starch, albuminoids and extractive of unknown composition, but containing no alkaloidal qualities. Petroleum ether, when percolated through the powder until the latter was exhausted, yielded, on evaporation, .8 per cent. of extract. The residue left, after treatment with petroleum ether, was exhausted with sulphuric ether, and the ether distilled off. This extract is entirely soluble in alcohol. By fusing the extract with caustic potash, and applying the usual test for vegetable acids, no reaction is obtained. The etherial extract thus obtained was 1.12 per cent. From the second residue an absolute alcoholic extract was obtained, which amounted to 1.9 per cent. The petroleum-ether extract consisted mainly of fat, accompanied with chlorophyl. The fusing point of this fat was 47.5° C.; congealed very readily, showing the presence of a higher carbonaceous fat. It gave a number of interesting color reactions. The etherial extract contained more chlorophyl, and a soft resin. The alcoholic extract was not examined for proximate principles.

With a view of detecting, by a short process, any alkaloids, two experiments were made, as follows:

Ten grammes of the finely-powdered drug were macerated with a mixture of 66 volumes of ether, 5 volumes of alcohol, and 2 volumes of alcohol, for 24 hours. The etherial solution filtered off, and agitated with 15 cc. of water, containing a little sulphuric acid. The ether evaporated off. The residue, tested with Mayer's reagent, gave no reaction.

Fifty grammes were next treated with 3 per cent. of oxalic acid solution at 60° C.; the filtered solution neutralized with ammonia and evaporated to nearly a syrupy condition. This was shaken briskly with ether, the etherial solution decanted and allowed to evaporate. The residue, treated with water acidulated with sulphuric acid and tested with Mayer's reagent, as well as other general reagents for alkaloids, gave no reaction for the presence of such a principle.

Distillation of the powdered leaves from potash lye developed a decidedly unpleasant odor, but upon an examination of the distillate no proof was evinced of the presence of a volatile active principle. The above experiments were made only as a preliminary examination of the plant, as a study of its behavior to various processes merely; the writer will take up the subject more completely in the near future. It has been but a few weeks since the plant was sent to the laboratory. A thorough analysis will require several months. A more exhaustive chemical examination is now in process, and will be reported at next meeting.

PHYSIOLOGICAL EXAMINATION.

Through the kindness of Mr. R. E. Steele, referred to above, there was presented an excellent opportunity to personally observe and study the physiological effects of the plant upon animals. A cow had been eating loco for the past year or so, and

had been "crazy"—suffering from the effects of the indulgence for a long time, but, since grass was becoming abundant and loco scarce on the pasturage, she had very recently been improving. This animal was placed at my disposal for examination. Dr. Harding, of Dodge City, was engaged to assist in the contemplated post-mortem, but as he was found too busy at the time, I was thrown upon my own resources. Fortunately, however, I was not without valuable assistance. Mr. A. J. Smith, a recent graduate of the department of pharmacy, who had also taken the preliminary medical course of the University, accompanied me, and we, together with Mr. Steele to do the butchering and heavy work, made the post-mortem. The animal was four years old, but Mr. Steele said no larger than she was at two years. The feeding upon loco had not only stopped her growth, but made her quite poor and gave her a wasted appearance. She seemed stupid and debilitated, unsteady in her movements, the breathing was short and rapid, and muscular force very much impaired. Whether walking or standing, the head was unsteady and trembling. It was seemingly beyond her power to so control the muscles as to keep her head perfectly still. Mr. Steele stated that a sort of wild stare had been in her eyes, but that had recently disappeared.

POST-MORTEM.

The blood was light but not abnormal; having no instrument at hand, it was not microscopally examined. The paunch was in a normal condition; the reticulum and psalterium were softened and apparently diseased. Through the entire length of the intestines there seemed to be a degeneration of tissue, being on the inside peculiarly soft. Two or three perforations were observed in the small intestine. Both the large and small intestines were delicate, devoid of elasticity, and even upon careful handling in some places they would be torn or broken apart. The tissue seemed to be, as one expressed it, rotten in some places. The peritoneum and omentum were inflamed, and throughout were found tumors about the size of a pea, which were fleshy in appearance and of a fibrous nature. The pleura appeared normal, as also did the diaphragm. The pericardium was streaked with red on the inner side, the sac containing about a pint of liquid of a pale yellow color. The heart seemed to be about one-third larger than the normal size. The mitral and tricuspid valves were inflamed around the edges. The valves of the aorta appeared normal, and just above them the serous coat was streaked with red; in other respects appeared normal. The bile was thin and watery, even after standing twenty-four hours. The pancreas and spleen appeared normal; kidneys normal; inner coat of bladder softened. The membranes of the brain were congested and adherent. The congestion may have been caused by the blow on the head previous to killing the animal. She was, however, only stunned by a light blow, and then immediately bled to death. The brain itself appeared paler than normal, but the bleeding may have caused this. The membranes of the spinal cord were inflamed and adherent. The cord itself appeared normal.

Evidently the disease was one of the mucous and serous membranes, which would account for the nervous and debilitated condition of the animal. The general diseased condition of the alimentary canal, by interfering with digestion and proper nutrition, would account for stunted growth and weakness in traveling. This pathological condition would indicate a treatment recommended by Dr. Harding, as follows:

Pulverized extract belladonna	10 grs.
Corrosive sublimate	1 to 1½ grs.
Licorice	1 oz.
Glycerine	q. s.

Mix. Make a thin paste, and give a tablespoonful. The belladonna and mercury may be increased according to the severity of the symptoms. Opium combined

with belladonna might be advantageous at the beginning of the disease. Mild and non-irritating articles of food only should be given, such as oil cake, etc. A veterinarian in Garden City recommended the application of a blister behind the ear. This might be good, as also any counter-irritant application along the spine. I am especially indebted for these conclusions and much assistance in making up this report, to Dr. Harding (above referred to), and Dr. Budd Smith, of Grenada, Col.

This examination, while it is very interesting, does not form a basis for any very positive conclusions. It will be necessary, to continue the investigation, to perform a number of like operations. It is very desirable to repeat the experiment of Dr. Harding—all of which the writer is preparing to do as soon as he is able.

ON THE VARIATIONS IN THE SUGAR-CONTENT OF *SORGHUM VULGARE*.

BY J. T. WILLARD.

Individual specimens of all species of plants may be assumed to vary in composition between certain limits. When the variable constituent is a substance of value to man, a determination of the causes of variation and its degree, becomes of importance. Further, we might reasonably hope that, by selecting seed from plants containing the largest percentage of the valuable constituent, the amount might be gradually but permanently increased. This system of seed selection is, of course, commonly practiced, and many of our best varieties of cultivated plants have been produced in this way. But, so far as the writer has been able to ascertain, this system has never been applied to sorghum by saving seed from plants which show by analysis a larger percentage of sugar than the average.

There are some difficulties in the way of improving sorghum by this method. The ordinary farmer cannot apply it, because he has no means of determining the sugar-content of his stalks of cane unless he has a chemist at command. The officials of the Department of Agriculture have never attempted anything of the kind, perhaps because it would require several years of observation before anything definite could be ascertained, and they, like the rest of mankind, desire immediate results, and have little object in inaugurating a series of experiments only to see a successor come in and either take all the credit or drop the work.

The plan of the experiment to be described was this: Kansas Orange sorghum was selected as the variety at present best for this State. By individual analysis of a number of stalks of a size and proportion suitable for perpetuation, I expected to determine if there were any appreciable variations in their sugar-content; then by planting seed from the best stalk, all things considered, I hoped to be able to fix the good qualities of this stalk. It might also be expected that the plants produced by seed from this stalk would exhibit variations in their sugar-content, and that by again planting seed from the best stalk the average might be raised still higher. By continuing in this way a number of years, it seemed possible to so increase the percentage of sugar in sorghum as to make it a much more valuable plant.

The experiment was begun in the spring of 1885, by planting a small amount of Kansas Orange sorghum seed. The soil was in fair condition only. The seed was poor, so that replanting was necessary, making the crop late. The season was, on the whole, rather favorable to the growth of the plant, although it was injured somewhat by drouth. Ten analyses connected with this experiment were made, all after the seed was dry and hard. One of these was of a bent stalk, and the result showed it

to be so inferior to the others that it will not be considered further in making comparisons. The following table shows in detail the analyses of the nine other stalks:

ANALYSES OF SINGLE STALKS OF SORGHUM, 1885.

Number.	Height in inches	Weight in pounds	Weight of juice extracted	Per cent. of juice	Polarization	Specific gravity	Per cent. of sucrose in juice	Per cent. of reducing sugar in juice
1	75	1.538	.796	51.7	40.00	1.0563	9.85	2.23
2	72	1.470	.708	48.1	64.50	1.0811	15.53	1.06
3	73	1.104	.534	48.3	57.30	1.0737	13.84	2.09
4	65	1.064	.523	49.1	50.10	1.0669	12.11	2.10
5	73	1.347	.652	48.4	55.90	1.0743	13.50	1.91
6	74	1.305	.646	49.5	54.50	1.0725	13.25	2.09
7	61	1.026	.435	42.3	59.30	1.0838	14.48	2.85
8	66	.944	.430	45.5	66.40	1.0808	15.84	1.25
9	68	1.133	.563	49.7	41.20	1.0665	12.51	1.73
Average	.....	.....	.....	.....	54.35	.....	13.43	1.92
Maximum	.....	.....	.....	.....	66.40	.....	15.84	2.85
Minimum	.....	.....	.....	.....	40.00	.....	9.85	1.25

It may be seen from the above table, that there is a wide variation in the composition of the juice from the different canes. All the stalks were straight, upright, and apparently healthy. They were weighed and measured with the leaves and upper joint removed. The saccharimeter used is of the Soleil-Scheibler pattern, and the reducing sugar was determined by Soxhlet's modification of the Fehling method.

The seed from number two was saved, as that stalk seemed best, all things considered, notwithstanding number eight had a slightly higher percentage of sucrose. Seed from this stalk was planted in the spring of 1886. It germinated well; the ground was in excellent condition, and the crop grew vigorously, many stalks standing over ten feet in height. The protracted drouth of August and September injured it badly, however, over one-third of the leaves being killed. Other analyses made by the writer have plainly showed that this killing of the leaves of the plant injures the quality of the juice in a marked degree. Twelve partial analyses were made. Owing to a press of work, the analyses were not as complete as those of the year before, in most cases only the polarization of the juice being determined. The stalks showing extreme results were fully analyzed. The average polarization was 56.33. The best stalk was 76 inches in height, weighed 1.867 pounds, and yielded 50.3 per cent. of juice, of specific gravity 1.08156, and containing 15.73 per cent. of sucrose and 1.89 per cent. of reducing sugar. The juice polarized 65.52. By comparing this with the stalk from which seed was planted, it will be seen that there is a considerable increase in the size and weight, a slight increase in the specific gravity of the juice, a slight increase in the per cent. of sucrose, and a greater increase in the per cent. of reducing sugar. The results, while showing no marked improvement, are encouraging, in that they show that cane grown from the selected seed was more than able to hold its own in an exceptionably unfavorable season. To what exent the improved condition of the soil is to be credited, is a matter which cannot be determined. The results are not regarded as conclusive, and the experiment will be continued in the future as long as it seems profitable, if opportunity permits.

NO. 2.

Substance.	Grams per litre.	Grains per U. S. gallon.
Potassium Oxide	.18438	7.83677
Sodium Oxide	.17780	10.36894
Lithium Oxide	.00300	.17495
Calcium Oxide (as bicarbonate)	.23256	13.60143
Calcium Oxide (not as bicarbonate)	.54838	31.98043
Magnesium Oxide (as bicarbonate)	trace.	trace.
Magnesium Oxide (not as bicarbonate)	.76086	44.34268
Ferrous Oxide (as bicarbonate)	.01197	.69807
Sulphuric Acid (SO_3)	2.64284	154.12514
Chlorine	.02113	1.23227
Phosphoric Acid (P_2O_5)	.00024	.01400
Boric Acid	trace.	trace.
Silica	.02098	1.22351
Carbonic Acid present, but not determined.		

NO. 3.

Substance.	Grams per litre.	Grains per U. S. gallon.
Potassium Oxide	.06687	3.89972
Sodium Oxide	.13088	7.63266
Calcium Oxide (as bicarbonate)	trace.	trace.
Calcium Oxide (not as bicarbonate)	.29865	17.41667
Magnesium Oxide (not as bicarbonate)	.09341	5.44748
Ferrous Oxide (as bicarbonate)	.04536	2.64530
Sulphuric Acid, (SO_3)	.78970	46.05372
Chlorine	.01690	.98557
Phosphoric Acid (P_2O_5)	.00039	.02275
Silica	.03320	1.93616
Carbonic Acid not determined.		

NO. 4.

Substance.	Grams per litre.	Grains per U. S. gallon.
Potassium Oxide	.00419	.24434
Sodium Oxide (as bicarbonate)	.13389	7.80796
Sodium Oxide (not as bicarbonate)	.02123	1.23807
Lithium Oxide	.00010	.00594
Strontium Oxide	trace.	trace.
Calcium Oxide (as bicarbonate)	.05740	3.34745
Calcium Oxide (not as bicarbonate)	.00336	.19571
Magnesium Oxide (as bicarbonate)	.02605	1.51936
Magnesium Oxide (not as bicarbonate)	.01080	.62962
Alumina	trace.	trace.
Manganous Oxide (as bicarbonate)	.00080	.01647
Ferrous Oxide (as bicarbonate)	.00068	.03948
Sulphuric Acid (SO_3)	.01200	.69982
Chlorine	.03550	2.07052
Thiosulphuric Acid (hyposulphurous acid, S_2O_2)	.00720	.41989
Hydrogen Sulphide (sulphuretted hydrogen)	.01105	.64441
Silica	.00670	.39078
Sulphur in suspension and free Carbonic Acid, not determined.		

The Hydrogen Sulphide is equal to 7.27 cc. per litre, or 1.68 cu. in. per gallon. No other sulphides were present.

LOCO WEED.

(Astragalus mollissimus; Nat. Ord. Leguminosæ.)

BY L. E. SAYRE, PH. G.,
Kansas State University, Department of Pharmacy.

The plant commonly known as Loco or Crazy Weed has for many years excited much curiosity, as being one which produces upon animals who feed upon it very peculiar and sometimes alarming effects. Indeed, it is said by ranchmen to cause many of the heaviest losses among their cattle and horses.

With a view of gathering some statistics concerning the effects of the weed upon animal life, and the extent of loss therefrom, I visited, in January last, certain parts of New Mexico and Colorado, and since the meeting of the Kansas Academy of Science* have made a special trip for the same purpose, visiting more especially the southwestern portion of Kansas, from Harper to Meade counties. The latter trip was occasioned by Mr. Robert E. Steele, on the "Crooked L" ranch at Meade Center, who wrote he had a locoed cow which he would place at my disposal for examination if I would take the journey to his ranch.

The plant begins to appear at about Medicine Lodge, and to extend southwesterly into the Indian Territory and northwesterly through the State of Kansas. At Dodge City it was found growing abundantly in spots, although no locoed animals could be found or heard of thereabouts. Ranchmen say they have not been so much troubled with it in recent years, but scores had lost heavily from it in years past. It was ascertained from what appears to be reliable authority, that about 500 animals have been lost in Meade county during the past five years from the effects of this weed, though occasionally a person was met with who firmly asserted that the plant in question did *not* cause the so-called loco disease. A butcher in Grenada, Colorado, who had been interested in raising cattle and horses, and seemed to be quite intelligent in his subject, most positively stated that "he did not believe one word of all that was said about the Crazy weed. He had read and heard a good deal, but he had yet to see an animal becoming affected by loco. He had pastured right in it, and never lost one animal." A number of others gave like testimony. It would be impossible in the brief space of this article to give the various and sometimes conflicting statements concerning this weed. Evidently there has been a lack of accurate and skillful observation in the matter. The great majority report that the plant is truly named, as it makes the animals not only crazy, but is sure to kill them eventually. Dr. P. Harding, of Dodge City, a veterinary surgeon, stated that at one time he was dealing quite extensively in horses, and had lost a number from what he believed to be the effect of loco. In order to satisfy himself, he performed two experiments upon horses, with the weed; the first experiment being in the field, and the next in the barn. In the field he pastured two horses, both horses having a taste for loco. One of the horses found abundance of the plant in his pasture; the other horse found *none*, because it had been carefully removed from his portion of the field. The first horse died in the pasture; the second recovered from the previous feeding. In the barn he also placed two horses similarly affected, and fed one with dried loco, the other with clean hay. The first died and the other recovered.

The following summary of the effect of loco is based upon personal inquiry among ranchmen. The animal unaccustomed to the weed will not touch it as long as good feed is to be had, but after once partaking of it — driven to it in early spring

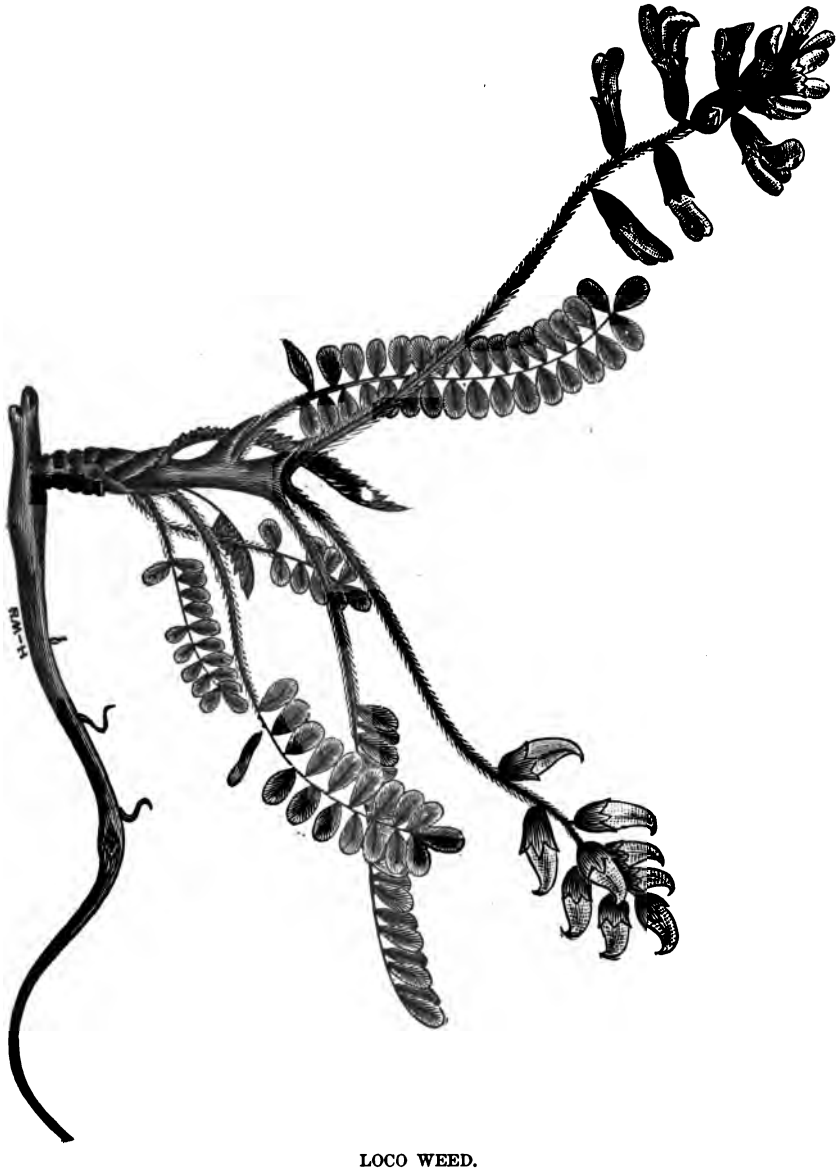
*The present paper is a revision of the one read at the last meeting of the Kansas Academy of Science, including the recent researches.

by the want of green vegetation — soon comes to prefer it to any other food, and finally refuses any other, leaves the herd and wildly searches for loco. The first effect upon the animal is hallucination. When led or ridden up to some trifling obstruction, such as a bar or a rope lying in the road, he stops short, and if urged on leaps over it as if it were a rail fence four feet high. Seemingly the optic nerve is affected; all sense of distance and dimension seems to be lost; a barn near at hand is to him afar off, and one a mile away near by. He will go headlong against a barn or a rock, or over a precipice, as if he were totally blind. The animal will, perhaps, let one get close to him, then suddenly and wildly run away at full speed and as suddenly stop, turn around, and it may be, come right back, stop short, stare, "and act like mad."

Mr. Wm. Smith, in the employ of Bollinger & Schlupp, ranchmen, seventeen miles south of Kiowa; Mr. D. R. Streeter, upon the "Z & Z" ranch, near Kiowa; and Mr. Steele, above referred to, are all quite familiar with the symptoms, and agree in every prominent particular concerning them. Mr. Steele gives as one of the prominent characteristics of the disease, "a stony stare." "If a sharp, quick motion is made before the animal's eyes, such as throwing up of the arms suddenly, it is likely to fall to the ground in apparent fright, as though not able to control its muscles." Sometimes a horse is seized as with a mania, in which he is quite uncontrollable and dangerous. He rears, even to falling backward, runs, or gives several successive leaps forward, and generally falls. His eyes are rolled upward until the whites can only be seen, which are strongly injected, and since he can see nothing is as apt to leap toward a wall or a man as in any other direction. Anything that excites him appears to induce such fits, which are perhaps more apt to occur in crossing water than elsewhere, and the animal sometimes falls so exhausted as to drown in water not over two feet deep. He loses flesh from the first, and presents the appearance of a skeleton. Nutritive energy seems to be paralyzed. In the last stage he only goes from loco to water and back. His gait is feeble and uncertain; eyes sunken, flat and glassy; his coat rough and lusterless, and in general the animal seems to suffer from starvation and constant excitement of the nervous system. Sometimes also he appears to experience acute pain, causing him to run from place to place, paw and roll until he falls, and then dies in a few moments. A correspondent from Texas states "he cannot tell when a horse is 'locoed' until he drives him very hard. After becoming heated he begins to be excited, and then the peculiar effect of loco appears."

There are two plants known as crazy weed, common in Kansas, Colorado, and New Mexico — the *Astragalus mollissimus*, and *Oxytropis Lamberti*, both belonging to the natural order Leguminosæ. E. A. Popenoe, Manhattan, states he has received from different parts, as specimens of crazy weed, beside the above, the following: *Malvastrum coccineum*, *Sophora sericea*, and *Amarantus albus;* but the writer has found from personal investigation that the farmers of our own and adjacent States mean by this title, "crazy weed," one or other of the two species above mentioned. Both the Astragalus and Oxytropis are rather attractive plants, and keep their color all winter.

The Astragalus grows on high ground and rather dry soil which is also gravelly and sandy. It blooms about June, and bears a bright-colored flower, rather attractive in its appearance. There are a great many stalks proceeding from the base. These stalks are reclining toward the base and erect and recurved above; subcaulescent, with soft, silky, villous pubescence. The leaflets usually in pairs, except the upper one (composed of from ten to twenty pairs) are somewhat densely clothed with soft, silky hairs. The flower stalk is usually longer than the leaf stalk, naked below, scape-



LOCO WEED.

like, bearing a rather thick spike of flowers, which have the general structure of the Leguminosæ.

CHEMICAL EXAMINATION.

In pulverizing the leaflets, the first portion which passes through the sieve consists almost wholly of the fine hairs which cause the pubescence to the structure. These hairs seem to constitute about one-third of the weight and over one-half of the bulk of the powder. From its light and spongy structure it is difficult to pulverize; the dust arising during the operation is irritating to the mucous membrane

—not from irritating principle residing in the plant, but from the immense quantity of broken, sharp-pointed hairs carried up with it. The light, fluffy character is remarkable, being one-tenth lighter than powdered senna.

PRELIMINARY EXAMINATION.

The air-dried powder was subjected to a temperature of 110° C., until it ceased to lose weight. The powder was found by this process to contain 10 per cent. of moisture. It was then incinerated in a platurium crucible, and yielded 12.01 per cent. of ash. The ash yielded to water 25 per cent. of soluble material, and to hydrochloric acid 50.6 per cent., the residue being largely silica. A qualitative analysis of the ash gave the following bases: CaO, K_2O, MgO, Al_2O_3, Fe_2O_3; and the following acid radicals: SO_3, Cl, P_2O_5, Co_2, and SiO_2.

The powdered drug yielded to water acidulated with hydrochloric acid 30.52 per cent., the solution evidently containing sugar, starch, albuminoids and extractive of unknown composition, but containing no alkaloidal qualities. Petroleum ether, when percolated through the powder until the latter was exhausted, yielded, on evaporation, .8 per cent. of extract. The residue left, after treatment with petroleum ether, was exhausted with sulphuric ether, and the ether distilled off. This extract is entirely soluble in alcohol. By fusing the extract with caustic potash, and applying the usual test for vegetable acids, no reaction is obtained. The etherial extract thus obtained was 1.12 per cent. From the second residue an absolute alcoholic extract was obtained, which amounted to 1.9 per cent. The petroleum-ether extract consisted mainly of fat, accompanied with chlorophyl. The fusing point of this fat was 47.5° C.; congealed very readily, showing the presence of a higher carbonaceous fat. It gave a number of interesting color reactions. The etherial extract contained more chlorophyl, and a soft resin. The alcoholic extract was not examined for proximate principles.

With a view of detecting, by a short process, any alkaloids, two experiments were made, as follows:

Ten grammes of the finely-powdered drug were macerated with a mixture of 66 volumes of ether, 5 volumes of alcohol, and 2 volumes of alcohol, for 24 hours. The etherial solution filtered off, and agitated with 15 cc. of water, containing a little sulphuric acid. The ether evaporated off. The residue, tested with Mayer's reagent, gave no reaction.

Fifty grammes were next treated with 3 per cent. of oxalic acid solution at 60° C.; the filtered solution neutralized with ammonia and evaporated to nearly a syrupy condition. This was shaken briskly with ether, the etherial solution decanted and allowed to evaporate. The residue, treated with water acidulated with sulphuric acid and tested with Mayer's reagent, as well as other general reagents for alkaloids, gave no reaction for the presence of such a principle.

Distillation of the powdered leaves from potash lye developed a decidedly unpleasant odor, but upon an examination of the distillate no proof was evinced of the presence of a volatile active principle. The above experiments were made only as a preliminary examination of the plant, as a study of its behavior to various processes merely; the writer will take up the subject more completely in the near future. It has been but a few weeks since the plant was sent to the laboratory. A thorough analysis will require several months. A more exhaustive chemical examination is now in process, and will be reported at next meeting.

PHYSIOLOGICAL EXAMINATION.

Through the kindness of Mr. R. E. Steele, referred to above, there was presented an excellent opportunity to personally observe and study the physiological effects of the plant upon animals. A cow had been eating loco for the past year or so, and

had been "crazy"—suffering from the effects of the indulgence for a long time, but, since grass was becoming abundant and loco scarce on the pasturage, she had very recently been improving. This animal was placed at my disposal for examination. Dr. Harding, of Dodge City, was engaged to assist in the contemplated post-mortem, but as he was found too busy at the time, I was thrown upon my own resources. Fortunately, however, I was not without valuable assistance. Mr. A. J. Smith, a recent graduate of the department of pharmacy, who had also taken the preliminary medical course of the University, accompanied me, and we, together with Mr. Steele to do the butchering and heavy work, made the post-mortem. The animal was four years old, but Mr. Steele said no larger than she was at two years. The feeding upon loco had not only stopped her growth, but made her quite poor and gave her a wasted appearance. She seemed stupid and debilitated, unsteady in her movements, the breathing was short and rapid, and muscular force very much impaired. Whether walking or standing, the head was unsteady and trembling. It was seemingly beyond her power to so control the muscles as to keep her head perfectly still. Mr. Steele stated that a sort of wild stare had been in her eyes, but that had recently disappeared.

POST-MORTEM.

The blood was light but not abnormal; having no instrument at hand, it was not microscopally examined. The paunch was in a normal condition; the reticulum and psalterium were softened and apparently diseased. Through the entire length of the intestines there seemed to be a degeneration of tissue, being on the inside peculiarly soft. Two or three perforations were observed in the small intestine. Both the large and small intestines were delicate, devoid of elasticity, and even upon careful handling in some places they would be torn or broken apart. The tissue seemed to be, as one expressed it, rotten in some places. The peritoneum and omentum were inflamed, and throughout were found tumors about the size of a pea, which were fleshy in appearance and of a fibrous nature. The pleura appeared normal, as also did the diaphragm. The pericardium was streaked with red on the inner side, the sac containing about a pint of liquid of a pale yellow color. The heart seemed to be about one-third larger than the normal size. The mitral and tricuspid valves were inflamed around the edges. The valves of the aorta appeared normal, and just above them the serous coat was streaked with red; in other respects appeared normal. The bile was thin and watery, even after standing twenty-four hours. The pancreas and spleen appeared normal; kidneys normal; inner coat of bladder softened. The membranes of the brain were congested and adherent. The congestion may have been caused by the blow on the head previous to killing the animal. She was, however, only stunned by a light blow, and then immediately bled to death. The brain itself appeared paler than normal, but the bleeding may have caused this. The membranes of the spinal cord were inflamed and adherent. The cord itself appeared normal.

Evidently the disease was one of the mucous and serous membranes, which would account for the nervous and debilitated condition of the animal. The general diseased condition of the alimentary canal, by interfering with digestion and proper nutrition, would account for stunted growth and weakness in traveling. This pathological condition would indicate a treatment recommended by Dr. Harding, as follows:

Pulverized extract belladonna	10 grs.
Corrosive sublimate	1 to 1½ grs.
Licorice	1 oz.
Glycerine	q. s.

Mix. Make a thin paste, and give a tablespoonful. The belladonna and mercury may be increased according to the severity of the symptoms. Opium combined

with belladonna might be advantageous at the beginning of the disease. Mild and non-irritating articles of food only should be given, such as oil cake, etc. A veterinarian in Garden City recommended the application of a blister behind the ear. This might be good, as also any counter-irritant application along the spine. I am especially indebted for these conclusions and much assistance in making up this report, to Dr. Harding (above referred to), and Dr. Budd Smith, of Grenada, Col.

This examination, while it is very interesting, does not form a basis for any very positive conclusions. It will be necessary, to continue the investigation, to perform a number of like operations. It is very desirable to repeat the experiment of Dr. Harding—all of which the writer is preparing to do as soon as he is able.

ON THE VARIATIONS IN THE SUGAR-CONTENT OF *SORGHUM VULGARE.*

BY J. T. WILLARD.

Individual specimens of all species of plants may be assumed to vary in composition between certain limits. When the variable constituent is a substance of value to man, a determination of the causes of variation and its degree, becomes of importance. Further, we might reasonably hope that, by selecting seed from plants containing the largest percentage of the valuable constituent, the amount might be gradually but permanently increased. This system of seed selection is, of course, commonly practiced, and many of our best varieties of cultivated plants have been produced in this way. But, so far as the writer has been able to ascertain, this system has never been applied to sorghum by saving seed from plants which show by analysis a larger percentage of sugar than the average.

There are some difficulties in the way of improving sorghum by this method. The ordinary farmer cannot apply it, because he has no means of determining the sugar-content of his stalks of cane unless he has a chemist at command. The officials of the Department of Agriculture have never attempted anything of the kind, perhaps because it would require several years of observation before anything definite could be ascertained, and they, like the rest of mankind, desire immediate results, and have little object in inaugurating a series of experiments only to see a successor come in and either take all the credit or drop the work.

The plan of the experiment to be described was this: Kansas Orange sorghum was selected as the variety at present best for this State. By individual analysis of a number of stalks of a size and proportion suitable for perpetuation, I expected to determine if there were any appreciable variations in their sugar-content; then by planting seed from the best stalk, all things considered, I hoped to be able to fix the good qualities of this stalk. It might also be expected that the plants produced by seed from this stalk would exhibit variations in their sugar-content, and that by again planting seed from the best stalk the average might be raised still higher. By continuing in this way a number of years, it seemed possible to so increase the percentage of sugar in sorghum as to make it a much more valuable plant.

The experiment was begun in the spring of 1885, by planting a small amount of Kansas Orange sorghum seed. The soil was in fair condition only. The seed was poor, so that replanting was necessary, making the crop late. The season was, on the whole, rather favorable to the growth of the plant, although it was injured somewhat by drouth. Ten analyses connected with this experiment were made, all after the seed was dry and hard. One of these was of a bent stalk, and the result showed it

to be so inferior to the others that it will not be considered further in making comparisons. The following table shows in detail the analyses of the nine other stalks:

ANALYSES OF SINGLE STALKS OF SORGHUM, 1885.

Number.	Height in inches	Weight in pounds	Weight of juice extracted	Per cent. of juice	Polarization	Specific gravity	Per cent. of sucrose in juice	Per cent. of reducing sugar in juice
1	75	1.538	.796	51.7	40.00	1.0563	9.85	2.23
2	72	1.470	.708	48.1	64.50	1.0811	15.53	1.06
3	73	1.104	.534	48.3	57.30	1.0737	13.84	2.09
4	65	1.064	.523	49.1	50.10	1.0669	12.11	2.10
5	73	1.347	.652	48.4	55.90	1.0743	13.50	1.91
6	74	1.305	.646	49.5	54.50	1.0725	13.25	2.09
7	61	1.026	.435	42.3	59.80	1.0838	14.48	2.85
8	66	.944	.430	45.5	66.40	1.0808	15.84	1.25
9	68	1.133	.563	49.7	41.20	1.0665	12.51	1.73
Average	.....	.....	.....	.....	54.35	.....	13.43	1.92
Maximum	.....	.....	.....	.....	66.40	.....	15.84	2.85
Minimum	.....	.....	.....	.....	40.00	.....	9.85	1.25

It may be seen from the above table, that there is a wide variation in the composition of the juice from the different canes. All the stalks were straight, upright, and apparently healthy. They were weighed and measured with the leaves and upper joint removed. The saccharimeter used is of the Soleil-Scheibler pattern, and the reducing sugar was determined by Soxhlet's modification of the Fehling method.

The seed from number two was saved, as that stalk seemed best, all things considered, notwithstanding number eight had a slightly higher percentage of sucrose. Seed from this stalk was planted in the spring of 1886. It germinated well; the ground was in excellent condition, and the crop grew vigorously, many stalks standing over ten feet in height. The protracted drouth of August and September injured it badly, however, over one-third of the leaves being killed. Other analyses made by the writer have plainly showed that this killing of the leaves of the plant injures the quality of the juice in a marked degree. Twelve partial analyses were made. Owing to a press of work, the analyses were not as complete as those of the year before, in most cases only the polarization of the juice being determined. The stalks showing extreme results were fully analyzed. The average polarization was 56.33. The best stalk was 76 inches in height, weighed 1.867 pounds, and yielded 50.3 per cent. of juice, of specific gravity 1.08156, and containing 15.73 per cent. of sucrose and 1.89 per cent. of reducing sugar. The juice polarized 65.52. By comparing this with the stalk from which seed was planted, it will be seen that there is a considerable increase in the size and weight, a slight increase in the specific gravity of the juice, a slight increase in the per cent. of sucrose, and a greater increase in the per cent. of reducing sugar. The results, while showing no marked improvement, are encouraging, in that they show that cane grown from the selected seed was more than able to hold its own in an exceptionably unfavorable season. To what exent the improved condition of the soil is to be credited, is a matter which cannot be determined. The results are not regarded as conclusive, and the experiment will be continued in the future as long as it seems profitable, if opportunity permits.

PRELIMINARY REPORT CONCERNING THE EFFECTS OF OXYGEN UPON ANIMAL LIFE.

T. H. DINSMORE, JR., EMPORIA, KAS.

For some time past, doubts have been entertained in the minds of thoughtful scientific workers as to the correctness of the commonly accepted views concerning the effects of oxygen upon animal life. It has been taken for granted (1) that animals placed in oxygen would almost immediately manifest signs of intoxication; (2) that in a very short time death would ensue as a result of abnormal combustion. In experimenting upon this matter we endeavored to find answers to the following questions:

(1) In case of intoxication, what length of time must elapse before it takes place?

(2) How soon, if at all, would death ensue?

(3) Whether the effects would vary with different kinds of animal life?

(4) Whether new data might be obtained?

In experimenting we used mice and kittens, confining them in large jars of pure oxygen.

RESULTS.

(1) The mice manifested, with the exception of a more rapid breathing, no signs whatever of intoxication.

(2) After remaining in the oxygen an hour they were apparently as well as when first placed in the gas.

(3) The kittens, half-grown, showed no signs of excitement except more rapid breathing.

(4) They were, as a rule, left in the gas from 30 to 60 minutes, but one after an hour and a half was taken out in an unconscious condition.

OUR CONCLUSIONS.

(1) That animals placed in pure oxygen do not become intoxicated within a short time.

(2) That oxygen does not cause death from abnormal combustion.

(3) That the loss of consciousness on the part of one kitten was due more to an excess of carbonic acid and other impurities exhaled from its lungs than to the effects of oxygen.

(4) That all animals when first exposed to pure oxygen will breathe more rapidly until the lungs become accustomed to the new medium. (New.)

(5) That upon different kinds of animal life the effects of oxygen are comparatively the same.

Our experiments will be repeated, and the subject more fully investigated, during the coming year.

MOUNDS IN DAVIS COUNTY.

BY CHAPLAIN JOHN D. PARKER, U.S.A., FORT RILEY.

In Davis county, three miles and a half northwest of Junction City, are four mounds, probably constructed by mound-builders. They are located on a bluff of the Republican river, about one mile south of the river and something more than a hundred feet above the river-bed. The mounds are found on the highest point of the bluff overlooking the Republican valley, which is here about a mile and a half wide. Three of the mounds are in the form of a semi-circle, with its convexity toward the south. The fourth mound is located east of the others, about three

hundred feet from the western mound, and the other mounds in the crescent are about eighty feet apart. The western mound is thirty feet in diameter, and when discovered was three and a half feet in height. The eastern mound is twenty feet in diameter, and when discovered was two feet in height. The other two mounds are twelve feet in diameter, but have been nearly obliterated by the ravages of time, by the burrowing of animals, and by the despoliation of curious people.

These mounds were discovered by John Davis, Esq., of Junction City, who formerly owned the land on which they are located. In the year 1879, he employed a man to open the mounds, who spent several days in exploring them. Selecting the largest mound, he dug a trench from the circumference through the center, carefully removing the dirt and stones, which, without order, were packed together in a mass. The limestones in large number, packed with the dirt, have evidently been taken from a stratum of the same, which outcrops lower down the bluff.

It proved to be a mound of sepulture. The bodies seemed to have been laid on the surface of the ground, without any order, and the mound of mingled dirt and stones raised over them. The mound has been well dug out, and the interior now presents a mass of limestones of all sizes promiscuously thrown upon each other. The stones and some of the bones still retain evidences of heat having been applied when the bodies were buried. The number of teeth found would indicate that perhaps eight persons had been interred. Numerous fragments of the most primitive pottery—apparently urns—were found in the mound. Probably a hundred beads of soft limestone, and of encrinites, were taken from the mound. The teeth found were generally sound; although some were worn to the gums, but one tooth was found decayed. It is almost a certainty that one mound-builder had the toothache. There was one pipe found, in the shape of a double moccasin, three inches in length from toe to toe. The bowl of the pipe was in the center an inch deep. The stem entered at one toe; the other toe had no orifice. This pipe was accidentally broken. Probably a dozen or two arrowheads were found. Some of the bones bore marks of the teeth of wild animals. Possibly a skirmish may have taken place between hostile parties at this point. After the bodies of the slain had lain on the field, and been partly devoured by wild animals, the remains may have been gathered up and buried in these mounds.

RESULTS OF SOME EXPLORATIONS AMONG THE PUEBLO RUINS IN NEW MEXICO.

BY J. R. MEAD, WICHITA.

In western New Mexico, twenty miles north of Grant station, on the Atlantic & Pacific Railroad, there rises to the height of over 11,000 feet the burnt volcanic mountain known to the Mexicans as San Mateo, and to the Americans as Mount Taylor. This mountain is associated with the mythology, traditions and superstitions of the Zunis, the Acomas, the Lagunas and Navajoes, who inhabit the country now, as they did in 1539, when Friar Marcos de Nieza and Stephanus first came to spy out their country. In the apex of this mountain is a natural cavity, in which the pueblo people believe the Deity of rain and thunder resides, for around its peak the clouds first gather which send their life-giving floods into the valleys below; and annually parties from each of the pueblos visit the summit of the mountain, and in the cavity deposit their offerings of meal, beads, and bundles of curiously-ornamented sticks and painted feathers, after which they perform their religious ceremonies with as sincere devotion as their Mexican neighbors kneel before the cross. From the cavity three paths, kept open and clear of leaves and grass, spread out to the southwest like a huge

turkey's foot, the one to the left pointing to the town of Lagunas; the center, to the pueblo of Acoma, in plain sight upon its high rock, thirty miles distant; the third, towards the Zuni pueblo. These paths are for the Deity of the mountain to walk in when he comes out to visit his people.

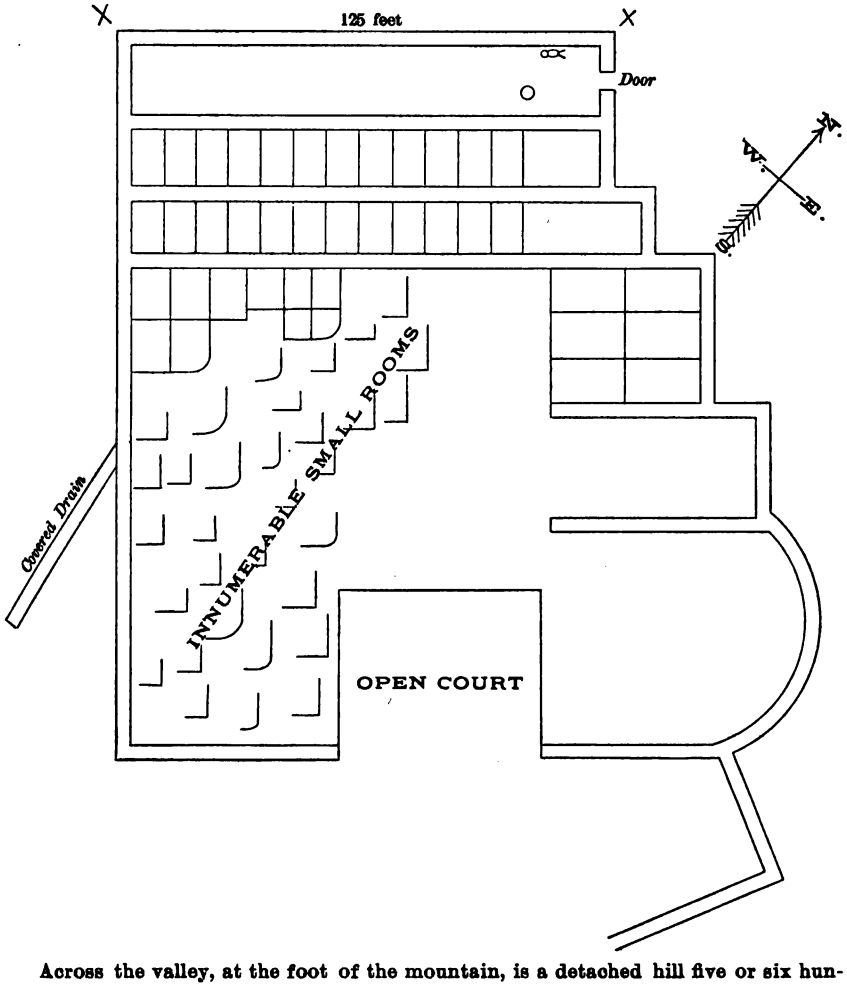
Down the northern slope of the mountain, through a forest of white-pine timber, runs a living stream of pure water, which supplies the primitive Mexican town of San Mateo, at the mountain's foot, and furnishes water to irrigate six or seven hundred acres of the valley, which the Mexicans cultivate as rudely as did the unknown people who builded a city and cultivated the same land centuries ago.

It was for the purpose of exploring these ruins that I visited this very interesting locality, especially interesting as it was but recently discovered by the owner of the land, Mr. Amado Chaves, with whose consent and assistance I employed some Mexicans and undertook to excavate the main central building, which, at a casual glance, appeared to be a natural mound of considerable size, composed of stone and earth, and covered with a scant growth of grass and weeds, but which proved to be a large communal building buried beneath the material of the fallen upper stories. Our excavation commenced at the northeast corner. Following the north wall 125 feet, which was standing to the top of the first story, 16 feet high, at the northeast corner we found a door 4 by 5½ feet, entering from the surface a room 14 feet wide, 14 feet high, and 122 feet long, inside measure. This room was entirely filled and covered with the material of the three or four stories fallen from above it. The door had been roughly stoned up from the outside, after the destruction of the building (as I afterward found), by people who had builded upon the ruins of the original building, and in their turn had been destroyed. The walls of the building were made of hard, smooth stone, skillfully laid in adobe mortar. The outside walls were 18 inches in thickness, both faces smooth and true, the angles apparently true right angles.

Near the door we uncovered a skeleton, which crumbled to pieces on exposure to the air. Nothing was found with it but the hair, which had faded to a brown color. Reports at the time stated it to be a white woman with red hair, and a string of costly beads about her neck. The loose material filling this room consisted of the fallen walls, adobe and cement floors, mingled with ashes, charred beams and plank, and broken pottery. Of at least three stories above in the original construction of the building, there was an accumulation of two feet of waste material—broken stone, mortar, pottery, &c. Instead of removing this, the builders had smoothed and pounded it down, plastered it with adobe mortar, and then covered it with a cement made of burnt gypsum, ashes, and pounded pumice stone, making a smooth, hard, white floor. The walls of the building rested upon the original surface of the soil. About fifteen feet from the entrance we exhumed a necklace of beads made from shells, jet, silver, and a large and beautiful turquoise. In course of our excavations we found numerous pottery vessels of various styles and patterns, broken metals, the bones of deer and turkeys, and charred corn-cobs of a very small variety. The building extended 150 feet south of this room, and was composed of innumerable small rooms, the labor of exploring which was far too great for me to undertake. The eastern wall was very peculiar—consisting of projections, angles, and curves, a sketch of which is shown on the opposite page.

This ruin was situated on the north side of the rich valley at the foot of the mountain, and traces of the ditch which brought the mountain stream by a circuitous route around and above the cultivated land, through their town, could still be seen. On all sides of this central building were the scattered remains of former habitations. The earth seemed full of broken pottery, ashes, charcoal, flint-chips, arrow-points, and other debris, to a depth of several feet. At the foot of a low, standstone ridge merely, a heavy rain exposed the top walls of a continuous series of connected rooms

an acre or two in extent, the walls sound and true as when first built. Burrowing coyotes enabled me to see four or five feet down the sides of some of these walls. This series of buildings were probably but one story high, and entirely buried by the blowing dust and sand. The burrowing animals (which were numerous) seemed to choose spots covering remains of some kind, as they invariably threw out pottery, stone-chips, arrow-points, and frequently, human bones. Wild potatoes grew plentifully about these ruins, and centipedes and rattlesnakes made their homes in the crumbling walls.



Across the valley, at the foot of the mountain, is a detached hill five or six hundred feet high, with precipitous rocky sides. The level summit, half an acre in extent, is entirely covered with the walls of rudely built houses. No traces of the timbers which once supported the roofs remain. These ruins are evidently of very great age. Pottery, ornamented and plain, abounds, and a few very delicate arrow-points of semi-transparent obsidian and agate were found, also turquoise beads and pendants worn in ears. In the abrupt south wall of the hill were the remains of cliff dwellings, built in every nook and cranny which would give them foothold. In

some instances the weathering away of the sandstone rock had carried away these little houses except the back wall and a deep bed of ashes, in which were bones of deer and birds, and vessels of pottery. I noticed several detached projecting rocks supported by a solid wall of stone laid in adobe mortar, and under the rock a bed of ashes two or three feet deep. On the east side of this hill, buried in the loose sand and earth, I found a human skeleton of unusual appearance. The bones were large, coarse and angular, the joints knotty, the legs excessively bowed, the skull small, with projecting jaws. It can be seen at the State University.

The Mexicans of San Mateo, only one or two of whom spoke English, told me of another ruined city, fifty miles northwest in an uninhabited country, destitute of water, and unknown to explorers. Waiting till the rainy season set in, I employed a Mexican guide well mounted, and set out in search of the unknown pueblo. An Indian trail followed alongside of or between walls of brilliant red and yellow sandstone 500 to 1,000 feet high. At an abandoned Navajo encampment we observed a number of Indian sweat houses made of poles leaning together, covered with bark and earth, air tight, large enough for one person to crawl in, first placing vessels of water inside, into which they put hot stones, while a friend outside closes the small entrance. The result is an extremely hot steam bath. The approach to the Continental Divide was very gradual; a carriage could be driven over our route by removing a few rocks and fallen trees. The divide is a level mesa half a mile in width, with a scattering, stunted growth of cedar, then in bloom, and the ground covered with the merest apology of a coat of grass, barely an inch high. At the western edge of the divide is a bed of calcite crystals, and lower down we rode over a cropping vein of lignite coal six or eight feet thick, of excellent quality. This vein extended along and cropped out of the high red-sandstone wall to our left like a black ribbon, for twenty miles, with 500 feet of sandstone above it, and the descending path we followed finally left it as many feet up the side of the cliff.

Towards evening of the second day the towering ruins we sought rose before us, situated on a gentle slope at the junction of two fertile valleys in the open plain. In the center of the town had been built the citadel, or fortress, its upper stories a fallen mass of ruins, except the center of the north wall, which, supported by a circular estufa, rose straight up from the ground for a distance of nearly 50 feet, including three full stories and a portion of the fourth. From the top of the first story, 16 feet above the ground, projected the ends of cedar beams 10 or 12 inches in diameter, indicating a veranda around the building. These projecting ends were so hard my knife failed to make an impression on them, yet the prevailing west wind had weathered away a quarter of their diameter on the exposed side. These heavy beams, more than twenty feet in length, were only found in the cañons of the high cliffs five miles distant. The north wall of this building was 136 feet in length, with a smooth, true face; six feet from the ground was a course of stone six to eight inches thick, and four feet long. With this exception the stone were of medium size, and decreased in thickness from the ground upwards. The first story contained 36 layers of stone, the second 35, the third 42, and the remnant of the fourth 31; in all, 144. Back of this building on rising ground is a circular estufa sunk in the ground, of unknown depth, as it is nearly filled with blowing dust. It is forty feet in diameter, a perfect circle, walled with smooth stone of uniform size, of 2x6-inch face. In front of the large building was a reservoir for holding water, supplied by a ditch running for half a mile west, which caught and conveyed the surface-water from a long slope in time of rain. We found no water except in pot-holes in the rock. A party of Navajoes passing, we offered them liberal pay to show us living water. They informed us there was none within a half-day's ride, and that a small spring to the west. On asking them what people built those houses, they referred to an old gray-haired Indian of their party, who after reflection said nobody knew — they were always there.

Abundant remains of lesser dwellings were on every side for a considerable distance around, and broken pottery very abundant. I exhumed one perfect skeleton, incased in dry adobe earth and covered with large, shallow, earthen vessels. The cranium would compare favorably with any European, and every tooth was perfect. The right arm had been broken, and united at an angle. I regretted my inability to bring this specimen with me for some of our State institutions.

The motive which decided the location of this pueblo was quite apparent. It was built near the point of a tongue of land at the junction of two fertile valleys, each of which were at the mouth of a large arroya, whose branches gathered the waters which fell in the high mesa in the rainy season, and poured them over the valleys at their mouths, where they sank into the loose, sandy earth, affording natural irrigation. Forty acres of corn were growing on this favored spot, planted by the Navajoes. I noticed no such stone as those used in the large buildings I have described, appear above-ground in the vicinity. The builders seem to have exhausted the supply. No names or inscriptions were found upon the rocks on this trip, and none found in the vicinity of the ruins. The scrubby timber growing in and about the ruins did not differ in appearance or age from that growing generally in the country. The only entrance to this large building was by a door at the northeast corner. The building faced southeast, as did the one at San Mateo.

Neither of the ruins I have described is marked in Wheeler's survey of the pueblo ruins of New Mexico, and the Indians and Mexicans stated they had never been visited by Americans to their knowledge. I saw numbers of lesser ruins in that section of the country. Pottery was scattered everywhere, even to the tops of the highest mountains. I conclude that the large buildings I have described are not of very ancient date — probably were built and occupied at the time of the Spanish conquest; but the ruins found by digging in the ground around them disclose the fact that other buildings preceded them which may be as old as man's occupation of this continent.

ADDITIONS TO THE CATALOGUE OF THE BIRDS OF KANSAS.

BY N. S. GOSS, TOPEKA.

The following observations have been made, and notes gathered, since the publication, May 1, 1886, of the Revised Catalogue of the Birds of Kansas.

PODILYMBUS PODICEPS. (Linn.). Pied-bill Grebe. June 8, 1886, I found the birds breeding in a pond in Meade county. I shot a young bird about two-thirds grown, saw several others, and caught a glimpse in the rushes of an old bird, followed by little chicks not more than a day or two old.

PHALAROPUS TRICOLOR. (Vieill.). Wilson's Phalarope. June 8, 1886, I found three pairs of the birds breeding on marshy grounds bordering a slough or pond of Crooked creek, Meade county, and I therefore enter the bird as an occasional summer resident in western Kansas; during migration, quite common throughout the State; nests on the ground, usually on hummocks, quite deeply excavated, and lined with leaves from the old dead grasses; eggs, three or four — usually four — ground color, cream to ashy drab, rather thickly but irregularly blotched with varying shades of brown to black. The female is larger and brighter in color than the male, but from limited observations of the birds I am led to think certain writers are mistaken in reporting that the females arrive first and do all the courting, but leave the work of nest-making, incubating, and rearing of the young to the males. I have never been so fortunate as to find either of the birds upon the nest; but certainly,

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both appear equally as watchful and solicitous, circling around and croaking as one approaches their nests or near their young, (grayish little fellows that leave the nest as soon as hatched.) The earliest arrival noticed in the State was at Neosho Falls, April 29, 1879. In this flock, as in all others seen at or about the time of their arrival, the sexes appeared to be about equally divided, and I am inclined to think further examination will prove the birds to be joint workers in the hatching and rearing of their young. And with a view to remove doubts, I trust all naturalists that are so fortunate as to be upon their breeding grounds during the breeding season, will carefully note and report their observations.

ÆGIALITIS NIVOSA (Cass.) Snowy Plover. Summer resident on the salt plains along the Cimarron river, in the Indian Territory, the northern limits of which extend across the line into southwestern Comanche county; quite common; arrive about the first of May; begin laying the last of May; nest, a depression worked out in the sand; eggs, three, 1.20x.90; pale olive drab, approaching a light clay color, with a greenish tint, rather evenly and thickly marked with irregularly-shaped, ragged-edged splashes and dots of dark or blackish brown. June 18, 1886, I shot two of the birds within the State limits, and saw one more, a female, with two young birds nearly half grown; and just south of the line, in the Indian Territory, I saw several of the birds and started one from a nest in the sand. It was without lining, and nothing near to shelter or hide it from view. The nest contained three eggs, nearly ready to hatch. Their dimensions were 1.20x.90, 1.20x.89, 1.22x.89. In an article published in the July number of the Auk, vol. 3, No. 3, p. 409, I said: "The birds are lighter in color, and the markings about the head not quite so distinct as the pair in my collection, shot at San Diego, California, in November, 1881. I therefore send two of the skins for examination, as I have not any specimens in the breeding plumage from the Pacific coast." This called forth the following note from the editor, Prof. J. A. Allen: "The two birds sent by Colonel Goss are very much lighter in color than the California specimens, taken in the breeding season, but agree exactly with a specimen in Mr. Sennett's collection, taken at Corpus Christi, Texas, May 24, 1882. These three examples differ markedly from the Pacific coast specimens, they showing only the merest trace of the fulvous tinge on the head, while the black markings are much paler, and the upper plumage generally presents a bleached or washed-out appearance. Doubtless additional material will show that the birds of the plains—from Texas northward to Kansas—are well entitled to subspecific separation." It is my intention to visit the grounds next season for the purpose of procuring additional specimens.

COLINUS VIRGINIANUS TEXANUS (Lawr.) Texan Bob-White. The birds are entered in the A. O. U. Check List as "Hab. southern and western Texas, north to western Kansas." On receipt of the list, I wrote Prof. Robert Ridgway, a member of the committee that prepared the list, to know when and where in the western part of the State the birds had been taken. In reply, he says: "*Colinus virginianus texanus*, as a bird of Kansas, rests on two specimens, adult females, in the National Museum, labeled, respectively, No. 34,425, Republican Fork, May 27, 1864; Dr. Elliott Coues, U. S. A., and No. 34,425, same locality, date, and collector. (See Hist. N. Am. B. 111, p. 474.) These specimens agree exactly with typical examples of *texanus* as compared with *virginianus* proper." Since the early settlement of the State I have known through report of military men and hunters, that Bob-Whites were occasionally seen on the Cimarron river. I never met with them there, and had taken it for granted that they were *C. virginianus;* but as the birds were found in western Kansas long before our Bob-Whites, in following up the settlements, reached the central portion of the State, I am now inclined to think further examination may prove the western bird of the

plains to be variety *texanus*, and that they reached that portion of the country by following north on the old military trails. I have written several persons in that region for specimens, but as yet have no reply.

EMPIDONAX PUSILLUS TRAILLII (Aud.) Traill's Flycatcher. Mr. George F. Brenninger, Beattie, Marshall county, has kindly sent me for examination a nest containing three eggs, taken July 17, 1886, in a thick second growth of timber, on the bank of a small creek at Beattie; and writes that he found in the same vicinity quite a number of nests. The earliest found, with a full set of eggs, was June 14th. In the Goss Ornithological Collection is a female, which I shot at Neosho Falls, July 26, 1881; and I have occasionally noticed the birds during the summer months, and have no doubt but what they will prove to be quite a common summer resident. I congratulate Mr. Brenninger on the find, and thank him for calling my attention to the same. The nests are usually placed in upright forks of the small limbs of trees and bushes, from four to ten feet from the ground. A rather deep, cup-shaped nest, closely resembling in form and make-up the nest of *Dendroica æstiva*, composed chiefly of small stems or twigs from plants, and flaxen, fibrous strippings from the same, with a few scattering blades of grass, and here and there an occasional feather, and lined thickly and rather evenly with fine, hair-like stems from grasses; eggs, three and four; dimensions of the three eggs sent, .70x.55, .70x.55, .69x.55, and of a set of four eggs taken June 17, 1881, at Galesburg, Illinois, .72x.55, .72x.55, .72x.54, .70x.54; cream white, thinly spotted and specked with reddish brown; thickest around large end; in form, oval.

SPIZELLA MONTICOLA OCHRACEA (Brewst.) Western Tree Sparrow. Prof. William Brewster, in "Notes on some Birds collected by Capt. Charles Bendire, at Fort Walla Walla, Washington Territory, Bull. Nutt. Orn. Club, October, 1882," vol. 7, p. 225, and under the head of "species and varieties calling for special consideration," p. 228 gives a full description of the bird, from a careful examination and comparison of the specimens before him with specimens of the typical eastern bird, and decided that the difference in coloration and markings was sufficient to rank it as a variety of *S. monticola*, and named the bird the Western Tree Sparrow, *S. monticola ochracea*, giving its habitat, "Western North America, east to Dakota, north to Arctic ocean; Alaska." On the 14th of October, 1883, I shot, at Wallace, several Tree Sparrows, and I was impressed at the time with the thought that they were somewhat paler in color, and different from specimens I had taken in the eastern part of the State; but on comparison I reached the conclusion they were the young birds of the year, and gave the matter no further thought until I noticed the bird entered in the A. O. U. Check List as occurring in "western Kansas." I at once wrote to Professor Brewster for typical specimens of both this and the eastern bird, which I received through his friend, Mr. Arthur P. Chadbourn, of Cambridge, Massachusetts. Just before receiving the specimens, viz., October 25, 1886, I killed three of the birds in Cheyenne county (northwest corner of the State). I now find, in comparing the specimens, that all the western birds, and a female in the Goss Ornithological Collection, taken November 22, 1878, at Neosho Falls, are in every respect similar in color to Mr. Chadbourn's specimen, labeled *S. monticola ochracea*, Ellis, Kansas, January, 1886. The specimens examined from eastern Kansas are nearly all the true *S. monticola*, the coloration being fully as rich and deep as that of the eastern specimen, taken in Middlesex county, Massachusetts, December 1, 1882. I therefore enter the Western Tree Sparrow as a winter resident, abundant in middle and western Kansas, and not uncommon in the eastern portion of the State. The western specimens, however, that I have examined, were all captured in the fall or early winter, and I should be led to think it possible that further examination, especially of the birds in their

spring plumage, might prove the paler form were to be the immature winter dress, it not for the fact that Professor Brewster, in making his examination, had before him not only his own large collection, but that in the National Museum, to aid him, which must have embraced specimens taken at different seasons of the year.

TURDUS USTULATUS SWAINSONII (Cab.) Olive-backed Thrush. June 6, 1886, I saw several of the birds in the timber skirting Crooked creek, in the northern part of Meade county; probably migrants, but so late in the season I think it worthy of mention.

NOTES ON A RED CEDAR SAW-FLY.*

BY C. L. MARLATT.

In the spring of 1885, during the latter part of April and the first of May, a number of saw-flies were observed about some red cedar trees in a yard near Manhattan. By beating the cedars with a sweep net a number of the insects were secured. The males were much more numerous than the females, and resembled them in little other than shape. In color the males are of a shining black, and are somewhat smaller than the honey-yellow-colored females; the antennæ of the former are broadly pectinate, of the latter minutely serrate. (Fig. 2, *d*, *c*.)

This saw-fly is nearly related to *Lophyrus fulvus* Nort. Specimens lately submitted to Mr. E. T. Cresson, of Philadelphia, are pronounced by him to be probably undescribed. If this saw-fly should prove to be unnamed, it may be called *Lophyrus* (*Monoctenus*) *juniperi*. A full description of both sexes is given below.

No careful search was made for larvæ, and none were found. The flies disappeared early in May.

On the 20th of April, 1886, the flies were again observed by me about the trees before mentioned, and a careful search resulted in finding some of the females depositing eggs in the twigs. Flies were afterward seen ovipositing on the cedars on the College grounds and elsewhere in the neighborhood. The following description of the method of oviposition is based on repeated observations of the female at work.

The fly selects a twig, usually green and new grown, and climbing to the extremity or near it, placing itself with its head away from the trunk, it extends its ovipositor (Fig. 2, *b*), and saws or drills through the scale-like leaf. From six to twelve minutes is occupied in depositing an egg, after which the insect flies to a new twig —but rarely is more than one egg placed in a twig before leaving it. The puncture made in the bract may be detected, though with difficulty, by the minute mass of "saw dust" at the point pierced. The punctured scale afterward dies, turns yellow, and becomes somewhat bulged by the increase of the egg in size—frequently cracking apart sufficiently to allow the egg to be seen. (Fig. 1, *c*.) The whitish oval egg, about $\frac{1}{24}$ of an inch long (Fig. 1, *b*), is found on lifting the scale pierced to be immediately beneath and placed in a direction parallel to it.

The female is much less active than the male, allowing a near approach, and may even be examined through a hand-glass while ovipositing. In early morning or on cool days, both sexes are quite sluggish and may be readily taken. In the warmer portion of the day the males, especially, may be seen flying briskly about the trees, easily taking alarm on a near approach, and when thus alarmed falling—flying off,

[*The notes on the life history of this Saw-Fly, and those following on the oviposition of the Buffalo Tree-Hopper, were made while the writer was acting as assistant in the Department of Entomology of the Kansas State Agricultural College; and as forming a part of the report of that department, they are reproduced here by permission.]

however, before reaching the ground. The oviposition of the female begins late in the forenoon, and continues till night, the act being repeatedly observed as late as 7 P. M.

From April 24th to May 13th an effort was made to keep some of the flies in a breeding-cage, to more carefully note their habits. The cage contained potted cedar, *Juniperus virginiana*, and the California redwood, *Sequoia gigantea*. The weather at this time was somewhat cool and stormy, and the flies mostly disappeared from the trees on the grounds. Although the breeding-cage above mentioned was kept in the College greenhouse, the insects did not appear to thrive, became sluggish, and died without depositing eggs, as observed.

MAY 3.—An examination of the eggs, now quite plainly visible, owing to the drying and cracking apart of the scale above them, showed them to contain nearly-formed larvæ, having well-defined segments and minute dark eye-spots. With the return of pleasant weather, the flies again appeared numerously about the cedars, and did not finally disappear before the 12th of May.

MAY 7.—Larvæ observed on terminal twigs near the egg-cases, from which they have evidently just emerged. Length $\frac{1}{8}$ inch; head brownish; eye-spots black; body with 22 feet—6 thoracic and 16 abdominal; color dirty green, having a dark appearance. The back has a transmitted pink tint, and the thoracic region is much swollen —$\frac{1}{4}$ greater in diameter than the abdominal portion; thoracic feet marked with black, appearing entirely black. (Fig. 3, *a*.) A number of larvæ and unhatched eggs were placed in a breeding-cage at this date, and these were added to at various times during the larval period.

MAY 12.—Larvæ first secured (on May 7) enter the first moulting stage. Lengths $\frac{1}{4}$–$\frac{3}{8}$ inch; body smooth, glossy, not slimy; color unchanged, except possibly to a lighter shade. The larvæ were abundant on the cedars at this time, and were observed to eat habitually the ends only of tender twigs.

MAY 18.—Second moulting. Length $\frac{3}{8}$–$\frac{1}{2}$ inch; no change noted in color and form.

MAY 20–22.—Third moulting: ground color of body as before given, marked, however, along the center of the dorsum, and half-way down on either side, by wide longitudinal grayish-black lines extending from the head to the last segment; length $\frac{1}{2}$–$\frac{5}{8}$ inch. (Fig. 3.)

MAY 25–29.—Fourth moulting: the three longitudinal lines above noted are better defined and of a darker color. (Alcoholic specimens of larvæ between the first and second moultings show, on careful examination, traces of these lines, though none were observed on living worms.) The usual pinkish tint of the central dorsal region almost wanting; length $\frac{3}{4}$ inch. The larvæ on the cedars on the grounds are abundant, and conspicuous from their size and color. Those in the breeding-cage are apparently thriving, feeding readily on cedar twigs, and somewhat sparingly on the redwood. When not feeding, the larvæ rest on terminal twigs, with their heads and thoracic regions elevated. If disturbed at any time the head and thoracic are thrown back over the body, and the thoracic feet protruded to their full extent, thus presenting a quite formidable appearance. (Fig. 1.)

On June 10th the larvæ, having attained a length of from 1 to $1\frac{1}{2}$ inches, began to enter the soil, and by the 15th of July all had thus disappeared, both in the breeding-cage and from the trees on the grounds. Nearly a month's difference will be noted in the oviposition of the earliest and latest eggs, and a corresponding or rather greater variation in the moulting stages of different larvæ, as shown in the time from the beginning of the fourth moulting to the final disappearance of the larvæ from the trees.

JULY 19.—The soil in the breeding-cage was sifted, and a number of cocoons of this saw-fly, $\frac{5}{16}$ of an inch long by about half as wide, taken from it. (Fig. 1, *a*.) The cocoon consists of two cases: the outer is dark, and covered with soil exteriorly, the inner surface brown-hued and glossy. The inner case is of a firmer texture, and of a showy crimson color, with pearly reflections on the inner surface. The cocoons contained contracted dormant larvæ; and when last examined, February 15, '87, no change had taken place; and it is probable that the pupal stage will be acquired but shortly before the appearance of the mature insects.

My observation of this saw-fly for the last two years leads to the belief that it is on the increase, and may at any time multiply to an injurious extent. With a view to find some easy means to check its ravages, a number of infested cedars were sprayed with a strong kerosene emulsion. About one-fourth of the larvæ died within twenty-four hours after the application; the others were apparently uninjured, though care was taken that all the larvæ should be reached. Experiments will be instituted the coming summer, looking to the discovery of more satisfactory results.

LOPHYRUS (MONOCTENUS) JUNIPERI, n. sp.

Female: Luteous yellow, shining; head and thorax slightly tinged with fulvous; a semi-circular line on the vertex covering the ocelli, tips of the mandibles, antennæ, excepting the two basal joints, mark on each side of the mesothorax, lateral scutellar region, tip of scutellum, metathorax, posterior portion of pectus, anterior margin of the basal plates, sides more or less of three or four or more — varying in different specimens — of the basal segments of the abdomen, central portion of the venter, sheaths, and tip of ovipositor, black; antennæ short, serrate, thirteen-jointed, the two basal joints in most cases luteous, tinged with fuscous. (In a few specimens the antennæ were entirely black, and in others and more commonly, the second joint only was luteous.) Mesothorax and scutellum smooth and polished; wings hyaline, iridescent, nervures and stigma black or fuscous, dividing nervure between the first and second submarginal cells hyaline, lanceolate cell contracted in the middle; tips of tarsi fuscous.

Length .35 inch.

Described from thirteen specimens.

Male: Shining black; palpi, sides of prothorax, and base of wings, luteous; antennæ usually seventeen-jointed, (about one-third of the specimens examined having but sixteen joints,) entirely black, and all but the two basal joints strongly pectinate; wings hyaline, iridescent, nervures and stigma black or fuscous, dividing nervure between the first and second submarginal cells hyaline, lanceolate cell contracted in the middle; legs luteous; coxæ, trochanters, and tips of tarsi, fuscous; terminal points of the abdomen and a wide stripe on either side of the venter, luteous.

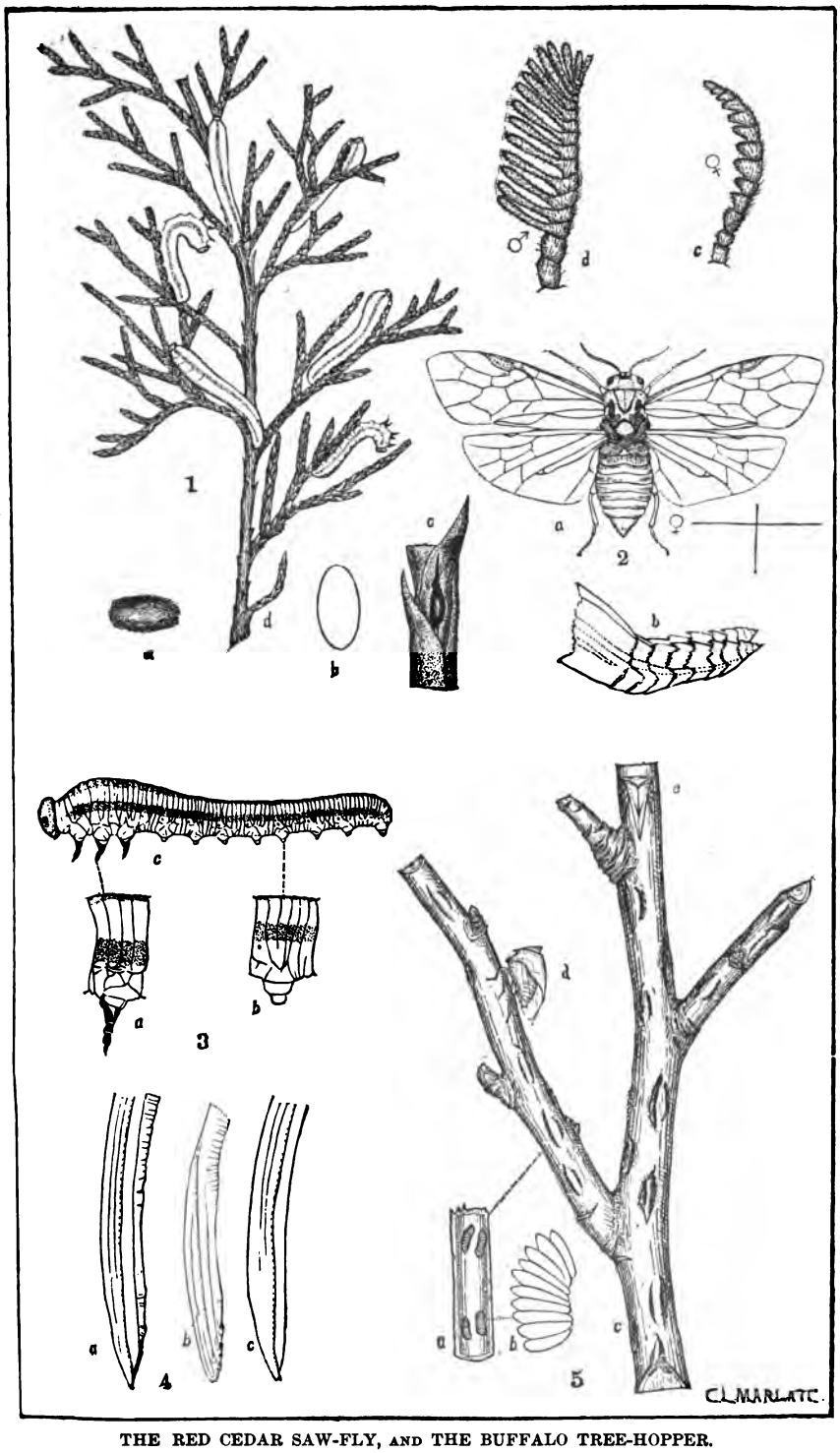
Length .30 inch.

Described from thirty-six specimens.

EXPLANATION OF PLATE.

RED CEDAR SAW-FLY.—Figure 1: *a*, cocoon; *d*, branch of cedar with larvæ feeding; *c*, egg in place in cedar leaf; *b*, outline of egg. Fig. 2: *a*, female saw-fly, showing characteristic venation of the wings; *d*, antenna of male; *c*, antenna of female; *b*, ovipositor. Fig. 3: *c*, full-grown larva, twice natural size; *a*, thoracic segment; *b*, abdominal segment. Fig. 1: *a* and *d*, natural size; others variously enlarged.

BUFFALO TREE-HOPPER.—Fig. 4: *a*, ovipositor in its sheath; *b*, the ovipositor, and *c*, one of the valves of the sheath, shown separately. Fig. 5: *c*, branch of apple, showing, at *d* and *e*, the insect at work, and the wounds made by it; *a*, portion of the bark lifted, showing the egg clusters, one of which is drawn in outline, much enlarged, at *b*.



THE RED CEDAR SAW-FLY, AND THE BUFFALO TREE-HOPPER.
(Figs. 1, 2 and 3 refer to the Saw-Fly; Figs. 4 and 5 to the Tree-Hopper.)

NOTES ON THE OVIPOSITION OF THE BUFFALO TREE-HOPPER.

BY C. L. MARLATT, MANHATTAN.

For a number of years past my attention has been drawn to the condition of the limbs and twigs in an old orchard near Manhattan. The upper side of the limbs on these trees have a very rough and scarred appearance, caused by thickly placed, irregularly-circular pits, one-eighth to one-fourth of an inch in diameter, extending through the bark into the sap-wood. Three years ago several hundred young trees were planted in and alongside the orchard in question. The following summer showed them to be covered to a greater or less extent with similar scars; and in the spring of 1885 these trees had assumed such an unhealthy appearance in consequence, that I was led to make a thorough examination of the affected limbs.

The older limbs containing the deeper scars presented no new features, but an examination of the scars in the wood of two years' growth showed them to contain whitish, slightly-curved eggs $\frac{1}{16}$ of an inch long, arranged in two parallel rows, separated by a narrow strip of bark, each row containing from five to twelve eggs. (Fig. 5, *a*, *b*.) On again opening the fresher scars in older limbs, some were found to contain eggs and others empty egg-cases.

Early in June the eggs were found to have mostly hatched, yet repeated examinations during the early summer showed no insect on the apple trees that could be attributed to the eggs, and all attempts to hatch them in a breeding-box, owing to the drying of the limbs and other unfavorable conditions, were unsuccessful.

On entering the orchard, about the first of September, large numbers of the Buffalo Tree-Hopper (*Ceresa bubalus*) were observed, on my near approach. to fly from me, with a loud buzzing noise, to other parts of the orchard. The presence of this insect in such numbers on the limbs of the apple immediately led me to think them the agents of the injury done; and after an hour's careful search, rendered doubly difficult by the swaying of the trees in a strong southwest wind, and the extreme shyness of the insect, one was seen in the act of inserting its eggs in a twig near the ground.

An examination of the work done by this tree-hopper, and similar punctures which were found in considerable numbers on the young limbs, showed them to be identical with the scars seen on the older limbs, the widening of the latter being caused by the growth of the wood. Repeated observation of the work of this insect, from September 6th to October 24th, forms the basis of the following account of its oviposition.

The female chooses by preference a twig of two or three years' growth, not, however, confining its work to limbs of this age. Eggs are deposited quite as readily in the new growth of old as of young trees; and my observation would lead me to believe that certain varieties, owing to differences in the texture of the bark, are more liable to be attacked than others. During oviposition, the female may head away from or toward the trunk. (Fig. 5, *d*, *c*.) A slightly curved slit through the outer bark is started with the ovipositor at right angles to the body, and the cut is made from the point of insertion posteriorly, the ovipositor constantly assuming a more and more slanting position as the cutting proceeds, till at the close it lies almost against the abdomen. At the beginning of this operation the body is raised on its limbs, and sways from side to side; but as the cutting continues backward the vibratory motion ceases somewhat, and the abdomen is lowered, till, on the completion of the slit, it rests on the twig. The insertion of the eggs immediately follows. Beginning at the end of the slit last made, the ovipositor is thrust down through the bark, reaching the cambium layer, the abdomen of the insect resting on the limb, and in-

clining in the direction of the ovipositor. At intervals of from ½ to 2 minutes, the ovipositor is drawn forcibly forward and sometimes partly out of the slit, and then reinserted. By noting the number of times this movement was repeated, it was found to agree with the number of eggs in the slit.

The making and filling with eggs of the first slit requires from 20 to 25 minutes, after which the ovipositor is entirely withdrawn, and a second slit, shorter than the first, parallel to and curving towards it, is made, without change of position by the insect. The ovipositor is inserted as during the oviposition of the first series of eggs, but at a very considerable angle from that then assumed. The introduction of the eggs in the second slit is as described for the first. The sheath of the ovipositor maintains, during oviposition, a rapid in-and-out motion.

On the completion of the slit as above described, a rest of considerable length is taken before the insect begins work again.

The number of eggs contained in each slit varies from six to twelve, or even more. A female which had been observed from the cutting of the first slit to the close of oviposition was then captured, and found still to contain 40 or more eggs. The first and second slits made by it contained respectively nine and ten eggs.

The eggs on either side are introduced from the farthest removed slit, and not from the one directly above them, as I had at first supposed. By this means the outer bark is cut loose from beneath; and when broken apart by the growth of the limb leaves the apparently single scar seen on the older limbs.

Ceresa bubalus does not confine its punctures to the apple; other plants — trees and even weeds — furnish receptacles for its eggs. On Sept. 30, last, numbers of this insect were observed depositing eggs on a willow in a ravine. The mode of procedure here was the same as on the apple; and the limbs presented a similar scarred appearance, caused by the work of the insect in previous years.

An examination of several neighboring orchards showed but little of the work of this insect. Their injurious abundance in the orchard in question and paucity in others near by is a noteworthy feature in the history of this insect.

The Buffalo Tree-Hopper, in both mature and larval stages, feeds on the juices of plants — not, however, confining its attacks to the apple — and probably in this way occasions but slight damage. The cutting-up of the bark to form receptacles for its eggs, however, is a serious injury to the tree, and one not easily prevented, owing to the activity of the insect and the impossibility of destroying its eggs without at the same time destroying the tree containing them. The commonly accepted but certainly erroneous account of the oviposition of this insect, given by Dr. C. V. Riley in his Fifth Missouri Report, page 121, forms the excuse for this paper. He says: "The egg-punctures of this Buffalo Tree-Hopper, *Ceresa bubalus*, ... consist of a row more or less straight of little raised slits in the bark, in each of which, upon careful examination, may be found an oval, dark-colored egg."

In a recent number of the *Canadian Entomologist*, Mr. J. G. Jack briefly describes the condition of bark cut up by the ovipositors of this insect, the eggs, and the larval stages. I failed to secure Mr. Jack's paper until my own had been written, but I find that his observations agree with mine wherever they cover the same ground.

NOTE ON A NEW VARIETY OF A SONORAN SERPENT FROM KANSAS.

BY F. W. CRAGIN, SC. B.

The specimen which serves as the basis of the following remarks is one of *Rhinochilus Lecontei*, B. & G., which was brought living to the writer in the summer of 1885, in Barber county, Kansas. It was taken by Master Chancy Smith, in a garden

in the town of Medicine Lodge. It essentially agrees with the generic descriptions given by Baird and Girard, and Garman. The large rostral plate, while "not prominent above" as compared with that of *Heterodon*, is nevertheless seen to have a slight absolute elevation, when viewed tangentially to the upper surface of the muzzle; it is also somewhat prominent at the sides, and is well produced anteriorly. While much less sharply compressed and pointed than in *Heterodon*, its peculiar and on the whole prominent development seems to indicate a burrowing habit. It departs noticeably from descriptions of *R. Lecontei* in the relation of the upper labials to the orbit—a fact to which Prof. Cope called my attention before I had studied the specimen. The upper labials are, as usual, eight in number—the seventh largest—but the fifth alone enters the orbit, nor does the fourth very closely approach it, being crowded out by the upper part of the fifth, which is laterally much produced. There are nine lower labials, the fifth largest. The ventral scutellæ are 206; the subcaudal 54, of which the first 45, the 47th, and the 49th, are entire, the others bifid.

Baird and Girard's description of this species says, "Prefrontals large compared to the post-frontals." It would certainly seem that this must be a mistake. In any event, the Kansas specimen is like most other serpents in having the post-frontals emphatically large as compared with the prefrontals. The loral plate is long and narrow. The orbitals and the number of rows of dorsal scales are as in other described specimens of this species.

The number of transverse dorsal black bands considerably exceeds that hitherto seen in this species, being forty-five—the thirty-third opposite the anus. The snout and the dorsal surface between the black bands are bright red, the lateral flecks in those bands bright yellow. The ventral surface of the body is rather sparsely marked with more or less subquadrate black spots of various sizes.

The tail is relatively somewhat longer than is indicated by authors for *R. Lecontei*, being $\frac{1}{7\frac{1}{3}}$ (or nearly $\frac{1}{8}$ instead of nearly $\frac{1}{9}$) of the total length.

This red and jet and golden reptile is, in life, one of the most beautiful serpents of North America. It might well be called the *Belle Snake*, in allusion to the elegance of its appointments. It is one of those brilliant faunal features so common in subtropical lands, and of which we see just the beginnings on the southern border of "sunny Kansas." The locality at which the specimen was found is not far from the isothermal line of 60°, which passes thence northwestward to the vicinity of Fort Wallace. The species, known only from the southwestern portion of its range (southern California) when first described, and later found at various localities to the southeast, east, and northeast, is here recorded from a locality which must represent nearly its extreme northeastern limit.

Previous to seeing this specimen, a snake which could hardly have been of other than this species was described to me as occurring a few miles west of Medicine Lodge. The species doubtless belongs also to the fauna of southern Colorado.

As this form is likely to prove but a variety of *R. Lecontei*, I will not venture to assign it a name, but will merely suggest that if it should at length appear that its distinctive characters are stable, it should be named after Prof. Cope, who is its true scientific discoverer.

ADDITIONS FOR 1885 AND 1886 TO THE LIST OF KANSAS COLEOPTERA.

BY WARREN KNAUS, M'PHERSON, KAS.

Of the following list, four species, Nos. 5581, 5587, 5613, and 5624, were taken by Mr. E. H. Kern, in Rooks county, in June and July, 1885. The remaining 51 species were taken principally in the counties of Rooks, Norton, Phillips, Cloud, Saline, and Finney. The collections from Rooks, Norton, Cloud, and Phillips counties were

made in July, 1885, and those from Finney county, in the immediate vicinity of Garden City, in May, 1886. With these additions, the list of Kansas Coleoptera comprises about 2,115 species, and Kansas still leads all other States of the Union in the number of catalogued Coleoptera. For the determination of the species of this list, many thanks are due Mr. Henry Ulke, of Washington, D. C.

The numbers prefixed are those of Henshaw's list:

24*a*. Cicindela violacea Fab. Saline and Riley counties.
59. Cicindela togata Laf. Cloud and Mitchell counties, July and August.
316. Bembidium bifossulatum Lec. Salina, October.
394. Bembidium constrictum Lec. Mitchell county, July.
——. Tachys near vittiger Lec. Salina.
676. Amara terrestris Lec. Finney county.
873. Lebia atriventris Say. Salina.
884. Lebia pleuritica Lec. Phillips and Saline counties, July.
962. Brachynus americanus Lec. Salina, April, May, and June.
970. Brachynus conformis Dej. Salina, April, May, and June.
1064. Agonoderus indistinctus Dej. Finney county.
1206. Anisodactylus cœnus Say. Salina.
2132. Staphylinus mysticus Er. Salina.
2175. Philonthus quadricollis Horn. Salina.
2274. Xantholinus emmesus Grav. Salina.
2305. Stenus renifer Lec. Salina, May.
2463. Stenus punctatus Er. Mitchell county, July.
2508. Cryptobium sellatum Lec. Salina, September.
2717. Bledius semiferrugineus Lec. Salina, Finney county.
2776. Trogophlœus memnonius Er. Salina.
2828. Olophrum obtectum Er. Salina.
2896. Eleusis pallidus Lec. Salina.
3142. Scymnus cinctus Lec. Salina, June.
3493. Hister dispar Lec. Salina.
3609. Saprinus plenus Lec. Finney county.
3649. Acritus exiguus Er. Salina.
3856. Monotoma picipes Hbst. Salina.
3964. Heterocerus mollinus Kies. Salina.
4132. Horistonotus Uhlerii Horn. Rooks county, July.
4313. Melanotus depressus Melsh. Salina, June.
4809. Polyclasis bifaria Say. Wabaunsee county, (Popenoe.)
5188. Hydnocera tricondylæ Lec. Norton and Phillips counties, July.
5312. Hemiptychus ventralis Lec. Salina.
5521. Aphodius crassulus Horn. Finney county.
5570. Aphodius Walshii Horn. Finney county.
5581. Ochodæus biarmatus Lec. Rooks county, June.
5587. Bradycinetus ferrugineus Bv. With the last.
5613. Trox scabrosus Bv. With No. 5581.
5624. Trox sordidus Lec. With No. 5581.
5785. Lachnosterna nitida Lec. Salina, May.
6619. Cryptocephalus guttulatus Oliv. Buffalo.
6913. Galeruca maritima Lec. Cloud county, August.
7105. Coptocycla purpurata Boh. Salina, August.
7207. Epitragus plumbeus Lec. Rooks county, July, August.
7817. Mordellistena aspersa Melsh. Mitchell county, July.
7843. Mordellistena morula Lec. Phillips county, July.

7866. Mordellistena æmula Lec. Rooks county, July.
7918. Notoxus talpa Laf. Rooks county.
7948. Anthicus confinis Lec. Salina.
7951. Anthicus difficilis Lec. Barton county, April, May.
8374. Apion floridanum Smith. Salina, August.
8628. Acalyptus carpini Hbst. Rooks county, July.
——. Anthonomus, not described. Phillips county, July.
8667. Anthonomus mixtus Lec. Salina, one specimen.
8677. Orchestes niger Horn. Salina, June.
8832. Cœliodes nebulosus Lec. Salina, June.
8885. Trichobaris plumbea Lec. Ottawa county, July.
8896. Onychobaris pectorosa Lec. Norton county, July.
——. Centrinus, not described. Buffalo.
9163. Hylesinus aculeatus Say. Salina, Norton and Dickinson counties, November.
9223. Brachytarsus alternatus Say. Phillips county, July.

SECOND LIST OF KANSAS PARASITIC FUNGI, TOGETHER WITH THEIR HOST-PLANTS.

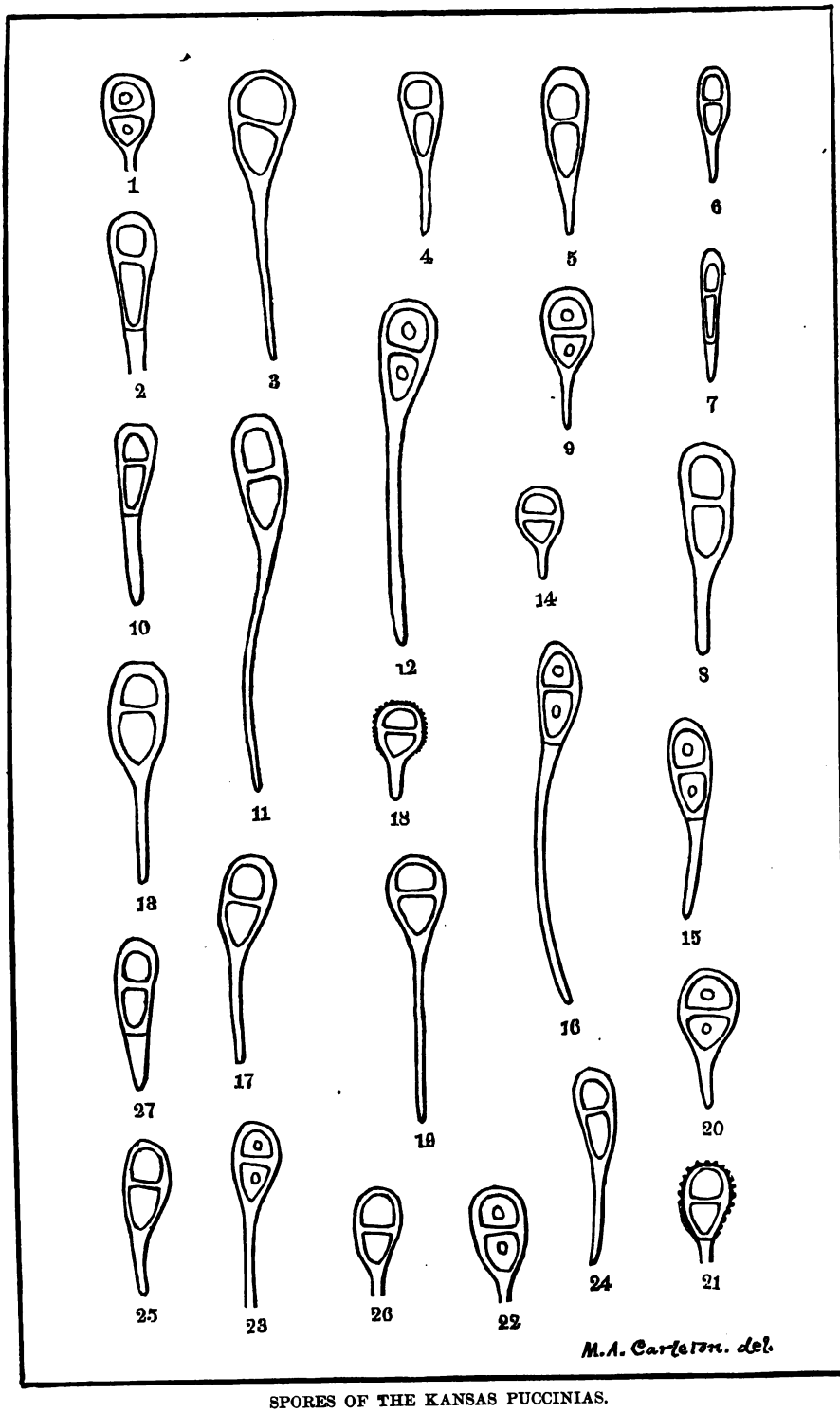
BY W. A. KELLERMAN, PH.D., AND M. A. CARLETON, MANHATTAN.

The fungi here enumerated (not limited strictly to the parasitic species) were collected for the most part in the vicinity of Manhattan, Riley county. A few of them, however, have been collected in adjoining counties, or in others but little farther distant, and it has not been thought necessary in such cases to name the special locality. The species numbered 4, 15, 33, 54, 60, 88, 107, 122, and 129, were collected in the western half of the State, but have not been seen elsewhere. The species not collected originally by ourselves have the name of the collector following in each case, but specimens have been submitted to us for examination. In this connection we would acknowledge with pleasure the kind assistance we have at all times had in the determination by Mr. J. B. Ellis of Newfield, New Jersey. The plate accompanying this paper contains a representation of the spores of all the species of Puccinia so far as found in this State, and will doubtless be of great assistance in determining the Kansas forms of this interesting genus.

EXPLANATION OF PLATE.

The numbers in parentheses refer to the List of Fungi. The figures are magnified about 320 diameters.

Fig. 1. Puccinia amorphæ, Curtis (19).
2. P. amphibii, Fuckl. (20).
3. P. artemisiarum, Duby (21).
4. P. asteris (22).
5. P. caricis, D. C. (23).
6. P. circææ, Pers. (24).
7. P. solida (25).
8. P. convolvuli, Cast. (26).
9. P. flosculosorum (A. & S.) (27).
10. P. galiorum, Lk. (28).
11. P. graminis, Pers. (29).
12. P. grindeliæ, Pk. (30).
13. P. helianthi, Sz. (31).
14. P. lateripes, B. & Rav. (32).
15. P. lithospermi, E. & K. (33).
16. P. malvacearum, Mont. (34).
17. P. maydis, Carrad. (35).
18. P. menthæ, Pers. (36).
19. P. nigrescens, Pk. (37).
20. P. petalostemonis, Farl. (38).
21. P. pruni-spinosæ (P.) (39).
22. P. saniculæ, Grev. (40).
23. P. seymeriæ, Burr (41).
24. P. silphii, Sz. (42).
25. P. smilacis, Sz. (43).
26. P. violæ, Schum. (44).
27. P. xanthii, Sz. (45).



SPORES OF THE KANSAS PUCCINIAS.

I.—LIST OF FUNGI.

USTILAGINEÆ.

1. Ustilago segetum (Bull.) (Uredo carbo, D. C.) On wheat and oats.
2. Ustilago Zeæ-Mays (D. C.) (U. Maydis, Lev.) On Zea Mays, L.
3. Ustilago Syntherismæ, Schw. On Panicum sanguinale, L.
4. Entyloma Compositarum, Farl. (?) On Gaillardia pulchella, Foug.
5. Entyloma Menispermi, Farl. and Trel. On Menispermum Canadense, L.
6. Entyloma Physalides (K. & C.) Winter (E. Besseyi, Farl.) On Physalis sp.
7. Doassansia Alismatis (Fr.) Cornu. On Sagittaria variabilis, Engl.

UREDINEÆ.

8. Uromyces Asclepiadis, Cke. (U. Howei, Pk.) On Ascelepias Cornuti, Dec.
9. Uromyces Caladii (Sz.) (U. Arisæmæ, Cke.) (Uredo Caladii, Sz.) On Arisæma Dracontium, Schott.
10. Uromyces Euphorbiæ, C. & P. On Euphorbia dentata, Mx., E. heterophylla, L., E. maculata, L., E. marginata, Ph., E. petaloidea, Engl., E. serpens, H. B. K., E. glyptosperma, Engl.
11. Uromyces Hedysari-paniculata, Sz. (U. Desmodii, Thüm., U. Desmodii, Cke.) On Desmodium sp.
12. Uromyces Lespedezæ (Sz.) (U. macrosporus, B. & C.) On Lespedeza capitata, Mx., L. violacea, Pers.
13. Uromyces Orobi, Winter. On Psoralea floribunda, Nutt.
14. Uromyces Phaseoli (Pers.) (U. appendiculatus, Lev.) On Phaseolus diversifolius, Pers., P. pauciflorus, Benth.
15. Uromyces Trifolii, f. Glycyrrhizæ, E. & K. On Glycyrrhiza lepidota, Nutt.
16. Uromyces Zygadeni, Pk. On Zygadenus Nuttallii, Nutt.
17. Pileolaria brevipes, B. & Rav. On Rhus toxicodendron, L.
18. Trichobasis Crotonis, Cke. On Croton monanthogynus, Mx.
19. Puccinia Amorphæ, Curtis. On Amorpha canescens, Nutt., A. fruticosa, L.
20. Puccinia Amphibii, Fuckl. On Polygonum Muhlenbergii L.
21. Puccinia Artemisiarum, Duby. On Artemisia Ludoviciana, Nutt.
22. Puccinia Asteris. On Aster sp.
23. Puccinia Caricis, D. C. On Carex sp.
24. Puccinia Circææ, Pers. On Circæa Lutetiana, L.
25. Puccinia solida, Sz. On Anemone Virginiana, L. (W. T. Swingle.)
26. Puccinia Convolvuli, Cast. On Calystegia sepium, L.
27. Puccinia flosculosorum, (A. & S.) (P. Compositarum, Schl., P. Troximontis, Pk.) On Vernonia Baldwinii, Torr., V. fasciculata, Mx., Troximon cuspidatum, Ph.
28. Puccinia Galiorum, Lk. On Galium Aparine, L.
29. Puccinia graminis, Pers. On various Gramineæ.
30. Puccinia Grindeliæ, Pk. On Grindelia squarrosa, Dun., var. grandiflora, Gr.
31. Puccinia Helianthi, Sz. On several species of Helianthus.
32. Puccinia lateripes, B. & Rav. On Ruellia ciliosa, Ph.
33. Puccinia Lithospermi, E. & K. On Evolvulus argentius, Ph. (which was originally supposed to be a Lithospermum.)
34. Puccinia Malvacearum, Mont. On Malvastrum coccineum, Gr.
35. Puccinia Maydis, Carrad, (P. Sorghi, Sz.) On Zea Mays, L.
36. Puccinia Menthæ, Pers. On Mentha Canadensis, L., Monarda fistulosa, L.
37. Puccinia nigrescens, Pk. On Salvia lanceolata, Willd. S. azurea, var. grandiflora.
38. Puccinia Petalostemonis, Farl. On Petalostemon candidus, Mx. P. multiflorus, Nutt. (W. T. Swingle.)

39. Puccinia Pruni-spinosæ, (P.) (P. Prunorum, Lk.) On Prunus Americana, Marshall.
40. Puccinia Saniculæ, Grev. On Sanicula Canadensis, L.
41. Puccinia Seymeriæ, Burr. On Seymeria macrophylla, Nutt. (W. T. Swingle.)
42. Puccinia Silphii, Sz. On Silphium integrifolium, Mx. S. laciniatum, L.
43. Puccinia Smilacis, Sz. On Smilax hispida, Muhl.
44. Puccinia Violæ, Schum. On Viola cucullata, Ait., V. delphinifolia, Nutt.
45. Puccinia Xanthii, Sz. On Xanthium Canadense, L. Ambrosia trifida, L.
46. Phragmidium subcorticium (Schrank.) (P. mucronatum, Lk.) On Rosa Arkansana.
47. Gymnosporangium macropus, Lk. On Juniperus Virginiana, L.
48. Melampsora populina (Jacq.) On Populus monilifera, Ait.
49. Melampsora Salicis-caprææ (Pers.), M. salicina, Lev. On Salix longifolia, Muhl., S. nigra, Marsh.

49*a*. Coleosporium Solidaginis, Thüm. On Solidago.

50. Coleosporium Sonchi-arvensis (Pers.) (C. Compositarum, Lev.) On Vernonia Baldwinii, Torr.
51. Coleosporium miniatum. On Rosa Arkansana.
52. Cæoma nitens, Sz. (C. luminatum, Sz.) On Rubus villosus, Ait., R. occidentalis, L.
53. Uredo Agrimoniæ, D. C. On Agrimonia Eupatoria, L.
54. Uredo Œnotheræ Vize.(?). On Œnothera Fremonti, Sims.
55. Uredo Quercus, Brand. On Quercus prinoides, Willd., Q. macrocarpa. Mx.
56. Æcidium abundans, Pk. On Symphoricarpus vulgaris, Mx. (W. T. Swingle.)
57. Æcidium Æsculi, E. & K. On Æsculus glabra, Willd.
58. Æcidium amphigenum, E. & K. On Baptisia leucophæa, Nutt.
59. Æcidium Apocyni, Sz. On Apocynum cannabinum, L. (W. T. Swingle.)
60. Æcidium asperifolia, Pers. (?) On Onosmodium Carolinianum, D. C.
61. Æcidium asteratum, Sz. On Aster sp.
62. Æcidium Caladii. On Arisæma Dracontium, Schott.
63. Æcidium Callirrhoes, E. & K. On Callirrhoe involucrata, Gr.
64. Æcidium Cassiæ, E. & K., n. s. On Cassia chamæcrista, L. (W. T. Swingle.)
65. Æcidium Ceanothi, E. & K. On Ceanothus ovalis, Bigelow.
66. Æcidium Cephalanthi, Seymour. On Cephalanthus occidentalis, L. (W. T. Swingle.)
67. Æcidium Compositarum, Mont. On Erigeron annum, Pers., Cacalia atriplicifolia, L., Silphium laciniatum, L.
68. Æcidium Convallariæ, Schum. On Polygonatum multiflora, All., Allium reticulatum, Fras., Smilacina stellata, Desf.
69. Æcidium Dicentræ, Trelease. On Corydalus aurea, Willd., var. occidentalis, Engl.
70. Æcidium Epilobii, D C. On Œnothera biennis, L.
71. Æcidium Fraxini, Sz. On Fraxinis viridis, Mx.
72. Æcidium Grossulariæ, D C. On Ribes rotundifolium, Mx.
73. Æcidium helianthatum, Sz. On Helianthus doronocoides, Lam., H. rigidus, Desf., H. giganteus, L.
74. Æcidium Impatientatum, Sz. On Impatiens fulva, Nutt.
75. Æcidium Jamesianum, Pk. On Acerates viridiflora, Ell., Asclepias tuberosa, L.
76. Æcidium Œnotheræ, Pk. On Œnothera biennis, L., Œ. serrulata, Nutt., Œ. sinuata, Nutt.
77. Æcidium Petalostemonis, Farl. On Petalostemon candidus, Mx., P. multiflorus, Torr.
78. Æcidium porosum, Pk. On Vicia Americana, Muhl., var. linearis, Wats.

79. Æcidium Psoraleæ, Pk. On Psoralea floribunda, Nutt., P. argophylla, Ph. (W. T. Swingle.)
80. Æcidium pustulatum, Curtis. On Comandra umbellata, Nutt.
81. Æcidium Ranunculacearum, D. C. On Anemone nemorosa, L. (W. T. Swingle.)
82. Æcidium Sambuci. On Sambucus Canadensis, L.
83. Æcidium Smilacis, Sz. On Smilax hispida, Muhl.
84. Æcidium verbenicolum, E. & K. On Verbena stricta, Vent., V. bracteosa, Mx., V. hastata, L.
85. Æcidium Xanthoxyli, Pk. On Xanthoxylum Americanum, Mill.
86. Isaria xylarioides, E. & K. On rotten wood.
87. Ceratium hydnoides, A. & S. On rotten wood.

SPHÆROPSIDIÆ.

88. Conothyrium herbarum, C. & E. On Yucca angustifolia, Ph.
89. Phoma ustulatum, B. & C.(?). On Vitis cordifolia, Mx.
90. Hendersonia Platani, Ph. On Platanus occidentalis.
91. Darluca filum, Cart. On Puccinia sp., Uredo sp.
92. Vermicularia albomaculata, Schm. (?) On Asimina triloba, Dun., Gymnocladus Canadensis, Lam.
93. Vermicularia compacta, C. & E. (?). On Ampelopsis quinquefolia, Mx.
94. Vermicularia dematium, Fr. On Ambrosia trifida, L.
95. Discosia maculicola, Ger. On apple leaves.
96. Discosia rugulosa, B. & C. On Carya sp.
97. Septoria Cacaliæ, E. & K. On C. atriplicifolia, L., C. tuberosa, Nutt.
98. Septoria Campanulæ, Math. (?) On Campanula Americana, L.
99. Septoria cannabina, West. On Cannabis sativa, L.
100. Septoria Cephalanthi, E. & K. On Cephalanthus occidentalis, L.
101. Septoria Erigerontis, Pk. On Erigeron Canadense, L.
102. Septoria gaurina, E. & K. On Gaura parviflora, Dougl.
103. Septoria Helianthi, E. & K. On Helianthus lenticularis, Dougl.
104. Septoria Inulæ, Sacc. & Spegz. On Helianthus mollis, Lam.
105. Septoria Kellermaniana Thüm. On Vitis cordifolia, Mx.
106. Septoria lythrina, Pk. On Lythrum alatum, Ph.
107. Septoria Mentzeliæ, E. & K. On Mentzelia ornata, T. & G.
108. Septoria Œnotheræ, West. On Œnothera biennis, L., Œ. serrulata, Nutt.
109. Septoria Pruni, Ell. On Prunus Americana, Marshall.
110. Septoria psilostega, E. & M. On Galium sp.
111. Septoria Rhoidis, B. & E. On Rhus glabra, L.
112. Septoria Ribis, Desm. On Ribes rotundifolium, Mx., R. aureum, Ph.
113. Septoria Rubi (Duby.) On Rubus villosus, Ait.
114. Septoria Sii, Desm. On Cicuta maculata, L.
115. Septoria Silenes, E. & M. On Silene noctiflora, L.
116. Septoria Specularis, B. & C. On Specularia perfoliata, D. C.
117. Septoria Stenosiphonis, E. & K. On Stenosiphon virgatus, Spach.
118. Septoria Verbenæ, Rob. & Desm. On various species of Verbena.
119. Septoria xanthifoliæ, E. & K. On Iva ciliatá, Willd., I. xanthiifolia, Nutt.
120. Phleospora Anemones, E. & K. On Anemone Virginiana, L. (W. T. Swingle.)
121. Phyllosticta acericola, C. & E. On Acer dasycarpum, Ehrh.
122. Phyllosticta Amaranti, E. & K. On Amarantus retroflexus, L.
123. Phyllosticta Ampelopsidis, E. & M. On Ampelopsis quinquefolia, Mx.
124. Phyllosticta cornicola, Desm. On Cornus paniculata, L'Her.
125. Phyllosticta Cornuti, E. & K. On Asclepias Cornuti, Dec.

126. Phyllosticta cruenta, Fr. On Polygonatum giganteum, Dietrich.
127. Phyllosticta Fraxini, E. & M. On Fraxinus viridis, Mx.
128. Phyllosticta Labruscæ, Thüm. On Vitis cordifolia, Mx.
129. Phyllosticta Mentzeliæ, E. & K. On Mentzelia ornata, T. & G.
130. Phyllosticta phaseolina, Sacc. On Phaseolus diversifolius, Pers.
131. Phyllosticta platanicola, E. & K. On Platanus occidentalis, L.
132. Phyllosticta serotina, Cke. On Prunus serotina, Ehrh.
133. Phyllosticta smilacina, E. & M. On Smilax hispida, Muhl.
134. Phyllosticta sphæropsoides, E. & E. (?) On Æsculus glabra, Willd.
135. Phyllosticta ulmicola, Sacc. On Ulmus fulva, Mx.
136. Phyllosticta verbascicola, E. & K. On Verbascum Thapsus, L.
137. Kellermannia yuccægena, E. & E. On Yucca angustifolia, Ph.
138. Chætomella perforata, E. & E. On Cnicus altissimus, Willd.

MELANCONEÆ.

139. Stilbospora ovata, Pers. On Acer dasycarpum, Ehrh.
140. Pestalozzia stellata, B. & C. On Platanus occidentalis, L.
141. Glœosporium fusarioides, E. & K. On Asclepias Cornuti, Dec.
142. Glœosporium septorioides, Sacc. On Quercus tinctoria, Bart.
143. Glœsporium stenosporum, E. & K. On Populus monilifera, Ait.

TORULACEÆ.

144. Gymnosporium (?) harknessioides, Ell. & Hol. On Rosa Arkansana.

STILBACEÆ.

145. Stilbum erythrocephalum, Ditm. On Rabbit dung.
146. Epicoccum sphærospermum, Berk. (E. neglectum, Desm.) On Zea Mays, L.

DEMATIEÆ.

146*a*. Sporocybe byssoides, Fr. On old stems.
147. Stachybotrys lobulata, Berk. On old paper.
148. Helminthosporium gracile, Wallr. On Iris sp. cult.
149. Ceratophorum uncinatum (Clinton.) On Carya amara, Nutt. (W. T. Swingle.)
150. Cercospora Acalyphæ, Pk. On Acalypha Virginica, L.
151. Cercospora altheina, Sacc. On Callirrhoe involucrata, Gr., Hibiscus Trionum, L.
152. Cercospora Apocyni, E. & K. On Apocynum cannibinum, L.
153. Cercospora Ascelepiadis, Ellis. On Asclepias Jamesii, Torr.
154. Cercospora Cephalanthi, E. & K. On Cephalanthus occidentalis, L.
155. Cercospora cercidicola, Ellis. On Cercis Canadensis, L.
156. Cercospora Chenopodii, Fres. On Chenopodium hybridum, L.
157. Cercospora chionea, E. & K. On Cercis Canadensis, L.
158. Cercospora condensata, E. & K. On Gleditschia triacanthos, L.
159. Cercospora Desmanthi, E. & K. On Desmanthus brachylobus, Benth.
160. Cercospora consociata, Winter. On Ruellia ciliosa, Ph.
161. Cercospora Desmodii, E. & K. On Desmodium acuminatum, Dec.
162. Cercospora Diantheræ, E. & K. On Dianthera Americana, L.
163. Cercospora effusa, (B. & C.) (Cladosporium effusa, B. & C.) On Lobelia cardinalis, L.
164. Cercospora flagellaris, E. & M. On Phytolacca decandra, L.
165. Cercospora Fraxini, E. & K. On Fraxinus viridis, Mx.
166. Cercospora glandulosa, E. & K. On Ailantus glandulosa, Desf.
167. Cercospora granuliformis, Ell. & Hol. On Viola cucullata, Ait.
168. Cercospora Gymnocladi, E. & K. On Gymnocladus Canadensis, Lam.

169. Cercospora Isanthi, E. & K. On Isanthus cæruleus, Mx.
170. Cercospora microsoma, Sacc. On Tilia Americana, L.
171. Cercospora moricola, Cke. On Morus rubra, L.
172. Cercospora murina, E. & K. On Viola cuculata, Ait.
173. Cercospora oculata, E. & K. On Vernonia Baldwinii, Torr.
174. Cercospora Pentstemonis, E. & K. On Pentstemon cobæa, Nutt., P. grandiflora, Fras.
175. Cercospora Physalidis, Ellis. On Physalis lanceolota, Lam. var. lævigata, Gr.
176. Cercospora Plantaginis, Sacc. On Plantago major, L.
177. Cercospora pustula, Cke. (C. Ampelopsidis, Pk.) On Ampelopsis quinquefolia, Mx.
178. Cercospora racemosa, E. & K. On Teucrium Canadense, L.
179. Cercospora rhuina, C. & E. On Rhus glabra, L.
180. Cercospora Teucrii, E. & K. On Teucrium Canadense, L.
181. Cercospora tuberosa, E. & K. (C. glaucescens, Wint.) On Apios tuberosa, Mœnch.
182. Cercospora velutina, E. & K. On Baptisia Australis, R. Br.
183. Cercospora Vernoniæ, E. & K. On Vernonia Baldwinii, Torr.
184. Cercospora Violæ, Sacc. On Viola sp. cult., V. cucullata, Ait.
185. Ramularia Armoraciæ, Fuckl. On Nasturtium Armoracia, Fr.
186. Ramularia arvensis, Sacc. On Potentilla Norvegica.
187. Ramularia Astragali, E. & Hol. On Astragalus Canadensis, L.
188. Ramularia Celastri, E. & M. (R. Celastri, Pk.) On Celastrus scandens, L.
189. Ramularia decipiens, E. & E. On Rumex Britannica, L.
190. Ramularia Euonymi, E. & K. On Euonymus atropurpureus, Jacq.
191. Ramularia Grindeliæ, E. & K. On Grindelia squarrosa, Dun., var. grandiflora, Gr.
192. Ramularia rufo-macularis, Pk. On Polygonum Muhlenbergia L.
193. Ramularia Tuslanei, Sacc. (R. Fragariæ. Pk.) On Fragaria sp. cult.
194. Ramularia variabilis, Fuckl. On Verbascum Thapsus, L.
195. Ramularia Virga-aureæ, Thüm. On Solidago Lindheimeriana.
196. Cylindrosporium angustifolium, E. & K. On Yucca angustifolia, Ph.
197. Cylindrosporium minor, E. & K. n. s. On Fraxinus viridis, Mx.
198. Cylindrosporium Tradescantiæ, E. & K. On Tradescantia Virginica, L.
199. Macrosporium inquinans. On Grindelia squarrosa, Dun.
200. Macrosporium Maydis, C. & E. On Zea Mays, L.
201. Macrosporium Solani, E. & M. On Datura stramonium, L.
202. Cladosporium herbarum, Lk. On dead stems.
203. Fusicladium fasciculatum, C. & E. On Euphorbia petaloidea, Engl., E. hypericifolia, L.
204. Gyroceras Celtis, Mont. On Celtis occidentalis, L.
205. Stigmella visianica, Sacc. (?) On Platanus occidentalis, L.

MUCEDINEÆ.

206. Cystopus Bliti (Biv.) Lev. (C. Amaranti, S.) On Amarantus retroflexus, L.
207. Cystopus candidus (P.) Lev. On Nasturtium Armoracia, Fr.
208. Cystopus Convolvulacearum, Otth. On Ipomœa leptophylla, Torr., I. hederacea, Jacq.
209. Cystopus Portulacæ (D. C.) On Portulaca oleracea, L.
210. Microstroma leucosporum, Niessl. On Juglans nigra, L.
211. Synchytrium Anemones, Wor. (?) On Thalictrum purpurascens.
212. Synchytrium decipiens, Farl. On Amphicarpæa monoica, Nutt.
213. Peronospora alta, Fckl. On Plantago major, L.
214. Peronospora Arthurii, Farl. On Œnothera biennis, L.

215. Peronospora australis, Spegz. (P. sicyicola, Trelease.) On Sicyos angulatus, L.
216. Peronospora Corydalis, De Bary. On Corydalis aurea, Willd., var. occidentalis, Engl.
217. Peronospora Halstedii, Farl. On Helianthus doronocoides, Lam., Ambrosia trifida, L., Artemisia Ludoviciana, Nutt., Silphium integrifolium, Mx., Vernonia Baldwinii, Torr.
218. Peronospora Oxybaphi, E. & K. On Oxybaphus Nyctagineus, Sweet.
219. Peronospora parasitica, (Pers.) Tul. On Draba Caroliniana, Walt., Sisymbrium canescens, Nutt., Lepidium Virginicum, L.
220. Peronospora Potentillæ, De Bary. On Potentilla Norvegica, L.
221. Peronospora sordida, Berk. On Schrophularia nodosa, L.
222. Peronospora viticola, B. & C. Cn Vitis sp. cult., V. cordifolia, Mx.
223. Oidium fructigenum, Pers. On decaying plums.
224. Oidium leucoconinum, Desm. On Rosa Arkansana, Ehrh.
225. Tricothecium griseum, C. & E. On Panicum sp.
226. Tricothecium roseum, Fr. On Hackberry bark.

SPHÆRIACEÆ.

227. Fusidium Ravenelianum, Thüm. (Ramularia Desmodii, Cke.) On Desmodium sp.

ASCOMYCETES.

228. Morchella esculenta.
229. Peziza occidentalis, Schw. On dead twigs.
230. Peziza vesiculosa, Bull. On manure heap.
231. Ascobolus pilosus, Fr. On Cow dung.
232. Exoascus deformaus (Berk.) (Ascomyces deformans, Berk.) On peach leaves.
233. Exoascus Pruni, Fuckl. On Prunus Americana, Marshall.
234. Uncinula macrospora, Pk. On Ulmus fulva, Mx.
235. Uncinula spiralis, B. & C. On Ampelopsis quinquefolia, Mx.
236. Microsphæra Euphorbiæ, B. & C. (?). On Euphorbia marginata, Ph.
237. Microsphæra Friesii, Lev. On Syringa vulgaris, L.
238. Microsphæra Platani. On Platanus occidentalis, L.
239. Podosphæra tridactyla, (Wallr.) (P. Kunzei, Lev.) On cult. cherry.
240. Phyllactinia suffulta, (Reb.) (P. guttata, Reb.) On Celastrus scandens, L.
241. Sphærotheca castagnei, Lev. On Bidens frondosa, L.
242. Erysiphe communis, Schl. On Amphicarpæa monoica, Nutt.
243. Erysiphe lamprocarpa, Lev. On Verbena and many other plants.
244. Chætomium chartarum (Eda.) On old paper.
245. Rhytisma acerinum, Pers. On Acer dasycarpum, Ehrh.
246. Claviceps purpurea, (Fr.) Tul. On rye, Elymus Canadensis, L.
247. Hypoxylon rubiginosum, Fr. On rotten log.
248. Hypoxylon tinctor, Berk. On willow log.
249. Phyllachora Lespedezæ, (Schr.) (Dothidea Lespedezæ, Schr.) On Lespedeza capitata, Mx.
250. Parodiella perisporioides, (B. & C.) On Psoralea floribunda, Nutt., P. argophylla, Ph.
251. Parodiella tetraspora, (B. & R.) On Maclura auriantica, Nutt.
252. Diatrype albopruinata, Schw. On Quercus prinoides, Willd.
253. Melanconis dasycarpa, E. & K. On Acer dasycarpum, Ehrh.
254. Ophiobolus acuminata, Don. (Sphæria carduorum, Wallr.) On Cnicus altissimus, Willd.
255. Ophiobolus porphyrogonas. (Tode.) Sacc. (Sphæria rubella, Pers.) On old stems of Scutellaria.

256. Physalospora Arthuriana, Sacc. On Iva xanthiifolia, Nutt.
257. Venturia orbicula. On Quercus macrocarpa, Mx.
258. Plowrightia (Schm.) (Sphæria morbosa, Schm.) On Prunus Americana, Marshall.
259. Sphæria ulmea, Schu. On Ulmus Americana, L.
260. Leptosphæria pyrenopizoides, S. & S. On Compositæ stems.
261. Epichloë typhina, B. On Gramineæ. (Mr. Thackeray.)
262. Sphærella cercidicola, E. & K. On Cercis Canadensis, L.
263. Sphærella decidua, E. & K. On Scrophularia nodosa, L., Vernonia Baldwinii, Torr.
264. Sphærella Lactucæ, E. & K. On Lactuca Canadensis, L.
265. Sphærella maculæformis, Pers. On Celtis occidentalis, L., Platanus occidentalis, L., Acer dasycarpum, Ehrh.
266. Sphærella Thalictri, E. & E. On Thalictrum purpurascens.

II.—LIST OF HOST PLANTS.

[The reference after each name is to the serial number in the List of Fungi.]

Abutilon Avicennæ.
Acalypha Virginica, 150.
Acer dasycarpum, 121, 139, 245, 253, 265.
Acerates viridiflora, 75.
Æsculus glabra, 57, 134.
Agrimonia Eupatoria, 53.
Ailantus glandulosa, 166.
Allium reticulatum, 68.
Amarantus retroflexus, 122, 206.
Ambrosia trifida, 45, 94, 217.
Amorpha canescens, 19.
Amorpha fruticosa, 19.
Ampelopsis quinquefolia, 93, 123, 177, 235.
Amphicarpæa monoica, 212, 242.
Anemone nemorosa, 81.
Anemone Virginiana, 25, 120.
Apios tuberosa, 181.
Apocynum cannabinum, 59, 152.
Apple leaves, 95.
Arisæma Dracontium, 9, 62.
Artemisia Ludoviciana, 21, 217.
Asclepias Cornuti, 8, 125, 141.
Asclepias Jamesii, 153.
Asclepias tuberosa, 75.
Asimina triloba, 92.
Aster, 22, 61.
Astragalus Canadensis, 187.
Baptisia Australis, 182.
Baptisia leucophæa, 58.
Bidens frondosa, 241.
Cacalia atriplicifolia, 67, 95.
Cacalia tuberosa, 97.
Callirrhoe involucrata, 63, 151.
Calystegia sepium, 26.
Campanula Americana, 98.
Cannabis sativa, 99.
Carex, 22.
Carya, 96.
Carya amara, 149.
Cassia chamæcrista, 64.
Ceanothus ovalis, 65.
Celastrus scandens, 188, 240.
Celtis occidentalis, 204, 265.
Cephalanthus occidentalis, 66, 100, 154.
Cercis Canadensis, 155, 157, 262.
Chenopodium hybridum, 156.
Cherry, 239.
Cicuta maculata, 114.
Circæa Lutetiana, 24.
Cnicus altissimus, 138, 254.
Comandra umbellata, 80.
Compositæ stems, 260.
Cornus paniculata, 124.
Corydalis aurea, var., 69, 216.
Croton monanthogynus, 18.
Datura stramonium, 201.
Dead stems, 202, 229, 146*a*.
Desmanthus brachylobus, 159.
Desmodium, 11, 227.
Desmodium acuminatium, 161.
Dianthera Americana, 162.
Draba Caroliniana, 219.
Dung, (cow,) 231.
Dung, (rabbit,) 145.
Elymus Canadensis, 246.
Erigeron annum, 67.
Erigeron Canadense, 101.
Euonymus atropurpureus, 190.
Euphorbia dentata, 10.
Euphorbia glyptosperma, 10.

Euphorbia heterophylla, 10.
Euphorbia hypercifolia, 208.
Euphorbia maculata, 10.
Euphorbia marginata, 10, 236.
Euphorbia petaloidea, 10, 203.
Euphorbia serpens, 10.
Evolvulus argenteus, 33.
Fragaria, 193.
Fraxinus viridus, 71, 127, 165, 197.
Gaillardia pulchella, 4.
Galium, 110.
Galium aparine, 28.
Gaura parviflora, 102.
Gleditschia triacanthos, 158.
Glycyrrhiza lepidota, 15.
Gramineæ, 29, 261.
Grindelia squarrosa, 30, 191, 199.
Gymnocladus Canadensis, 92, 168.
Hackberry bark, 226.
Helianthus, 31.
Helianthus doronicoides, 73, 217.
Helianthus giganteus, 73.
Helianthus lenticularis, 103.
Helianthus mollis, 104.
Helianthus rigidus, 73.
Hibiscus Trionum, 151.
Impatiens fulva, 74.
Ipomœa leptophylla, 208.
Ipomœa hederacea, 208.
Iris, 148.
Isanthus cærulea, 169.
Iva ciliata, 119.
Iva xanthiifolia, 119, 256.
Juglans nigra, 210.
Juniperus Virginiana, 47.
Lactuca Canadensis, 180, 264.
Lepidium Virginicum, 219.
Lespedeza capitata, 12, 249.
Lespedeza violacea, 12.
Lobelia cardinalis, 163.
Lythrum alatum, 106.
Malvastrum coccineum, 34.
Maclura auriantica, 251.
Manure heap, 230.
Menispermum Canadense, 5.
Mentha Canadensis, 36.
Mentzelia ornata, 107, 129.
Monarda fistulosa, 36.
Morus rubra, 171.
Nasturtium Armoracia, 185, 207.
Oats, 1.
Œnothera biennis, 70, 76, 108, 214.
Œnothera Fremonti, 54.
Œnothera serrulata, 76, 108.
Œnothera sinuata, 76.
Onosmodium Carolinianum, 60.
Oxybaphus nyctagineus, 218.
Panicum, 225.
Panicum sanguinale, 3.
Papaver, 147.
Paper, 147, 244.
Peach leaves, 232.
Pentstemon cobæa, 174.
Pentstemon grandiflorus, 174.
Petalostemon candidus, 38, 77.
Petalostemon multiflorus, 38, 77.
Phaseolus diversifolius, 14, 130.
Phaseolus pauciflorus, 14.
Physalis, 6, 175.
Physalis lanceolata.
Phytolacca decandra, 164.
Plantago major, 176, 213.
Plantanus occidentalis, 90, 131, 140, 205, 238, 265.
Plums, 223.
Polygonatum giganteum, 126.
Polygonatum multiflorum, 68.
Polygonum amphibium, 20, 192.
Populus monilifera, 48, 143.
Portulaca oleracea, 209.
Potentilla, 186.
Potentilla Novegica, 220.
Prunus Americana, 39, 109, 233, 252.
Prunus serotina, 132.
Psoralea argophylla, 79, 250.
Psoralea floribunda, 13, 79, 250.
Puccinia, 91.
Quercus macrocarpa, 55, 257.
Quercus prinoides, 55, 252.
Quercus tinctoria, 142.
Rabbit dung, 145.
Rhus glabra, 111, 179.
Rhus toxicodendron, 17.
Ribes aureum, 112.
Ribes rotundifolium, 72, 112.
Rosa Arkansana, 46, 51, 144, 224.
Rotten wood, 86, 87, 247.
Rubus occidentalis, 52.
Rubus villosus, 52, 113.
Ruellia ciliosa, 32, 160.
Rumex Britannica, 189.
Rye, 246.
Sagittaria variabilis, 7.
Salix longifolia, 49.

Salix nigra, 49.
Salvia lanceolata, 37.
Sambucus Canadensis, 82.
Sanicula Canadensis, 40.
Scrophularia nodosa, 221, 263.
Scutellaria, 255.
Seymeria macrophylla, 41.
Sicyos angulatus, 215.
Silene noctiflora, 115.
Silphium integrifolium, 42, 217.
Silphium laciniatum, 42, 67.
Sisymbrium canescens, 219.
Smilacina stellata, 68.
Smilax hispida, 43, 83, 133.
Solidago, 195, 49*a*.
Specularia perfoliata, 116.
Stems (of compositæ), 260.
Stems (dead), 202, 229, 146*a*.
Stenosiphon virgatus, 117.
Symphoricarpus vulgaris, 56.
Syringa vulgaris, 237.
Teucrium Canadense, 178, 180.
Thalictrum purpurascens, 211, 266.
Tilia Americana, 170.
Tradescantia Virginica, 198.
Troximon cuspidatum, 27.
Ulmus Americana, 259.
Ulmus fulva, 135, 234.
Uredo, 91.
Verbascum thapsus, 136, 194.
Verbena, 118, 243.
Verbena bracteosa, 84.
Verbena hastata, 84.
Verbena stricta, 84.
Vernonia Baldwinii, 27, 50, 173, 183, 217, 263.
Vernonia fasciculata, 27.
Vicia Americana, 78.
Viola, 184.
Viola cucullata, 44, 167, 172, 184.
Viola delphinifolia, 44.
Vitis cordifolia, 89, 105, 128, 222.
Vitis sp. cult., 222.
Wheat, 1.
Willow log, 248.
Wood (rotten), 86, 87, 247.
Xanthium Canadense, 45.
Xanthoxylum Americanum, 85.
Yucca angustifolia, 88, 137, 196.
Zea Mays, 35, 146, 200.
Zygadenus, Nuttallii, 16.

III.—INDEX TO THE GENERA.

[The numbers refer in each case to the first species of the genus in the List of Fungi.]

Æcidium, 56.
Ascobolus, 231.
Cæoma, 52.
Ceratium, 87.
Ceratophorum, 149.
Cercospora, 150.
Chætomella, 138.
Chætomium, 244.
Cladosporium, 202.
Claviceps, 246.
Coleosporium, 50.
Coniothyrium, 88.
Cylindrosporium, 196.
Cystopus, 206.
Darluca, 91.
Diatrype, 252.
Discosia, 95.
Doassansia, 7.
Entyloma, 4.
Epichloë, 261.
Erysiphe, 242.
Epicoccum, 146.
Exoascus, 232.
Fusicladium, 203.
Fusidium, 227.
Glœosporium, 141.
Gymnosporangium, 47.
Gymnosporium, 144.
Gyroceras, 204.
Helminthosporium, 148.
Hendersonia, 90.
Hypoxylon, 247.
Isaria, 86.
Kellermannia, 137.
Leptosphæria, 260.
Macrosporium, 199.
Melampsora, 48.
Melanconis, 253.
Microsphæria, 236.
Microstroma, 210.
Morchella, 228.
Oidium, 223.
Ophiobolus, 254.
Parodiella, 50.
Peronospora, 213.
Pestalozzia, 140.
Peziza, 229.
Phleospora, 120.

Phoma, 89.
Phragmidium, 46.
Phyllachora, 249.
Phyllactinia, 240.
Phyllosticta, 121.
Physalospora, 256.
Pileloaria, 17.
Plowrightia, 258.
Podosphæra, 239.
Puccinia, 19.
Ramularia, 185.
Rhytisma, 245.
Septoria, 97.
Sphærella, 262.
Sphæria, 259.
Sphærotheca, 241.
Sporocybe, 146*a*.
Stachybotrys, 147.
Stigmella, 205.
Stilbospora, 139.
Stilbum, 149.
Synchytrium, 211.
Trichobasis, 18.
Tricothecium, 225.
Uncinula, 234.
Uredo, 53.
Uromyces, 8.
Ustilago, 1.
Venturia, 257.
Vermicularia, 92.

THE KANSAS FOREST TREES IDENTIFIED BY LEAVES AND FRUIT.

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The artificial Key here given is for the rapid identification of the genera in the following list. Where there are several representatives under any genus, a second key has been given, by means of which the species may be readily determined. The short descriptions added will doubtless be found quite sufficient to verify the correctness of the identification. We have made use of such characters in the preparation of the keys as are most obvious, and by which the determination can be satisfactorily made during the growing season. The leaves have furnished most of these characters, but we have made use of others, as of the branches, trunks, and fruits, where satisfactory identification could not otherwise be made. The flowers, when conspicuous, are generally mentioned in the descriptions. The characters as given by Gray and other authors, we have made free use of, yet we have had at the same time the specimens before us in nearly all cases. The characterization of the wood is taken from Sargent's Report on the Forest Trees of North America.

This same authority has been followed in the nomenclature and arrangement of the genera and species. We have made his statements as to the geographical distribution the basis for the preparation of our list. A few trees have been given which have been as yet doubtfully or perhaps not at all actually found within the limits of the State, but have been detected in neighboring States. The eastern species of catalpa (C. bignonioides) is so generally and abundantly cultivated with our western form (C. speciosa) that we have included it in the list. A few of the species given may be only shrubby in this State, but we have thought best to include them. Perhaps it would be well, also, to reproduce Prof. Sargent's distinction between trees and shrubs, given in the Catalogue of Forest Trees, which is as follows:

"Species which grow from the ground with a single stem, either wholly or over a large portion of the area of their distribution, are admitted into the following catalogue without reference to the height or size they may attain."

The signs of degrees (°) and of minutes (′) are used in the descriptions for feet and inches, respectively.

KEY TO THE GENERA.

Lvs. deciduous, trees not cone-bearing (1).
Lvs. evergreen, needle-shaped or scale-like (47).

1. Lvs. simple (2).
1. Lvs. compound (36).
2. Lvs. alternate (3).
2. Lvs. opposite, or verticillate (34).
3. Lvs. entire (4).
3. Lvs. serrate, dentate, cut-toothed or lobed (9).
4. Branches more or less spiny or thorny (5).
4. Branches free from spines or thorns (6).
5. Lvs. nearly smooth, wedge-oblong, or oval-lanceolate; fr. cherry-like.....21 (Bumelia.)
5. Lvs. shining above, strongly veined beneath, ovate or ovate-oblong, fr. orange-like.....29 (Maclura.)
6. Lvs. broadly-ovate-cordate, 3′–4′ long, 4′–5′ wide.....16 (Cercis.)
6. Lvs. not as above (7).
7. Lvs. obovate-lanceolate, 6′–12′ long, pointed; fr. 3′–4′ long..... 1 (Asimina.)
7. Lvs. lanceolate-oblong, shining above, downy beneath; fr. an acorn.....33 (Quercus.)
7. Lvs. ovate or ovate-oblong; fr. globular, ½′–1′ in diameter (8).
8. Lvs. ovate, bark spicy, aromatic; twigs and foliage mucilaginous.....25 (Sassafras.)
8. Lvs. ovate oblong, thickish, bark astringent; fr. edible when ripe.....22 (Diospyros.)
9. Trunk or branches armed with thorns or spines (10).
9. Trunk and branches unarmed (14).
10. Lvs. very obscurely denticulate; fr. large, orange-like.....29 (Maclura.)
10. Lvs. plainly serrate, cut or toothed; fr. small or medium (11).
11. Lvs. finely serrulate, or serrate above the middle (12).
11. Lvs. coarsely or sharply serrate, cut or toothed (13).
12. Lvs. obovate and oblanceolate, serrate above the middle; thorns 2′–3′ long.....19 (Cratægus.)
12. Lvs. nearly lanceolate, finely serrulate, thorns not prominent.....17 (Prunus.)
13. Lvs. coarsely or doubly serrate, conspicuously pointed, ovate.....17 (Prunus.)
13. Lvs. sharply cut or toothed, roundish-ovate, ovate-oblong or obovate .....19 (Cratægus.)
14. Bark white, detached (at least on the branches) annually in thin plates, lvs. broad, palmately lobed.....30 (Platanus.)
14. Bark, &c., not as above (15).
15. Trees small, sometimes only shrubs (16).
15. Trees large, bark more or less furrowed or laminated (23).
16. Lvs. large, sometimes 3-lobed; twigs yellowish green, bark spicy. .....25 (Sassafras.)
16. Lvs. &c., not as above (17).
17. Lvs. mostly narrow elongated, leaf-like stipules deciduous, fr. a 1-celled pod.....37 (Salix.)
17. Lvs. and fr. not as above (18).
18. Lvs. obtusely or obscurely serrate or crenate-serrate (19.)
18. Lvs. sharply serrate, cut or toothed (20.)
19. Lvs. oblong-oval, parallel veins prominent, fr. purple, berry-like..... 7 (Rhamnus.)
19. Lvs. obovate, downy on the midrib beneath, fr. a red, berry-like drupe..... 5 (Ilex.)
19. Lvs. oblong or lanceolate, scarcely veiny, fr. greenish, acerb.....18 (Pyrus.)
20. Lvs. downy or somewhat pubescent; straight-veined, fr. a nut or hop-like (21.)
20. Lvs. glabrous, at least when mature; fr. an apple, or berry-like (22).
21. Bark brownish furrowed; fr. hop-like in appearance.....34 (Ostrya.)
21. Bark close, smooth, gray; fr. a nut with halberd-shaped bracts.....35 (Carpinus.)
22. Fr. purplish, sweet, ripe in June; lvs. oblong-ovate, 2′–3′ long, acuminate.....20 (Amelanchier.)
22. Fr. greenish, acerb; lvs. ovate or lanceolate.....18 (Pyrus.)
23. Lvs. broadly sub-cordate, often truncate at base or deltoid (24).
23. Lvs. not as above (25).
24. Lvs. serrate with incurved teeth; buds covered with varnish.....38 (Populus.)
24. Teeth not incurved, inner bark easily peeled off; buds unvarnished..... 2 (Tilia.)
25. Lvs. linear, lanceolate or ovate-lanceolate, stipules often conspicuous.....37 (Salix.)
25. Lvs. varying; not as above (26).
26. Lvs. lobed (27).
26. Lvs. serrate (28).
27. Fr. an acorn, bark with much tannin .....33 (Quercus.)
27. Fr. a drupe; twigs yellowish-green, bark spicy aromatic.....25 (Sassafras.)
28. Fr. blackberry-like; lvs. rough above, lobed only on young shoots.....28 (Morus.)

28. Lvs. with very large sinuate teeth; fr. an acorn.....33 (Quercus.)
28. Lvs., etc., not as above (29).
29. Lvs. smooth and shining above, serrate, with incurved teeth; raceme of white fls. in May.....17 (Prunus.)
29. Lvs., etc., not as above (30).
30. Lvs. rhombic-ovate, whitish beneath, twigs reddish, bark brownish, somewhat laminate.....36 (Betula.)
30. Lvs., etc., not as above (31).
31. Bark smooth, close, gray; fr. a nut, with halberd-lobed bracts.....35 (Carpinus.)
31. Bark, etc., not as above (32).
32. Bark brownish, furrowed, with fine, narrow longitudinal divisions; fr. hop-like.....34 (Ostrya.)
32. Bark coarse, branches sometimes corky-winged; fr. a drupe or samara (33).
33. Veins from the midrib straight and parallel, *veinlets obscure;* fr. a samara.....26 (Ulmus.)
33. Veins from the midrib irregular; *veinlets prominent;* fr. a small drupe.....27 (Celtis.)
34. Lvs. subentire or serrate; fr. a pod (35).
34. Lvs. palmately lobed; fr. a samara.....10 (Acer.)
35. Lvs. oval-oblong, serrate, 2′–5′ long, pod deeply lobed, crimson.....6 (Euonymus.)
35. Lvs. cordate, subentire, often verticillate, 1° long, pod long cylindric.....24 (Catalpa.)
36. Lvs. palmately compound, lfts. 5–7.....8 (Æsculus.)
36. Lvs. ternate, pinnate, or bi-pinnate (37).
37. Trunk or branches armed with spines, thorns or prickles (38).
37. Trunk and branches unarmed (40).
38. Lfts. 4–5 pairs; bark, lvs. and fleshy pod very pungent and aromatic.....3 (Zanthoxylum.)
38. Lfts. 6–12 pairs; bark, etc. not pungent or aromatic (39).
39. Lfts. lanceolate-oblong; thorns stout, often triple; pods 12′–18′ long, often twisted, 15 (Gleditschia.)
39. Lfts. ovate or oblong; branches armed with stipular prickles: pods 4′–6′ long.....13 (Robinia.)
40. Lvs. bi-pinnate, 1°–3° long; pod 6′–10′ long; bean hard, brown, smooth.....14 (Gymnocladus.)
40. Lvs. pinnate or ternate; fr. a samara or nut (41).
41. Lvs. opposite (42).
41. Lvs. alternate (43).
42. Lfts. 3–5; wood light, soft; twigs light green; fr. a double samara.....11 (Negundo.)
42. Lfts 5–9; wood heavy, tough; bark furrowed; fr. a samara.....23 (Fraxinus.)
43. Lfts. 3; fr. winged; tree small.....4 (Ptelea.)
43. Lfts. 5–many (44).
44. Tree small; fr. a small, dry drupe or a berry (45).
44. Tree large; bark rough; fr. a walnut or hickory-nut (46).
45. Lvs. odd-pinnate; fr. a small, dry drupe, red or whitish.....12 (Rhus.)
45. Lvs. abruptly pinnate; fr. a single or triple berry.....9 (Sapindus.)
46. Buds superposed, uppermost far above the axil; pith in plates; fr. a walnut, 31 (Juglans.)
46. Buds scaly, axillary; pith continuous; fr. a hickory-nut.....32 (Carya.)
47. Lvs. needle-shaped, 3′–5′ long, 2 or 3 in a fascicle; fr. a cone.....40 (Pinus.)
47. Lvs. scale-shape, acute; fr. a bluish berry.....39 (Juniperus.)

LIST OF TREES.

(Order Anonaceæ.)

1. Asimina. Papaw.

1. *A. triloba*, Dunal; Papaw. A small tree; wood light, soft, yellowish-green; lvs. 8′–12′ long, at first rusty downy, soon glabrous; fls. in early spring, dull purple; fr. 3′–4′ long, ripe in autumn.

(Order Tiliaceæ.)

2. Tilia. Basswood.

2. *T. Americana*, L.; Basswood, American Linden. A large tree, with light, soft wood; inner bark very strong; lvs. smooth and green on both sides, serrate, often truncate at base. The cluster of fragrant fls. with a peduncle that is a leaf-like bract.

(Order Rutaceæ.)

3. Zanthoxylum. Prickly Ash.

3. *Z. Americanum*, Miller; Prickly Ash. A small tree, often reduced to a shrub;

62. *Q. tinctoria*, Bartram; Black, Yellow, or Quercitron Oak. A large tree; wood heavy, hard, strong, not tough, coarse-grained. Lvs. glabrous or nearly so (pubescent beneath when young), oval or obovate-oblong, lobes oblong, obtuse, mucronate. Cup thick, 9 lines in diameter, covering half the acorn, which is broadly or globular-ovoid.

63. *Q. nigra*, L.; Black Jack, Jack Oak. A small tree; wood heavy, hard, strong. Lvs. broadly wedge-shaped (sometimes rounded at base), widely dilated and 3 (rarely 5) lobed at summit; rusty pubescent beneath, shining above; cup top-shaped; acorn short ovoid.

64. *Q. palustris*, Du Roi.; Pin Oak, Water Oak. A large or middle-sized tree; wood heavy, hard, very strong, coarse-grained. Lvs. glabrous or nearly so, oval or oblong-obovate, deeply pinnatifid with divergent lobes and broad, rounded sinuses; cup flat, saucer-shaped, very much shorter than the acorn, which is ovoid-globose, 5–7 lines long.

65. *Q. imbricaria*, Mx.; Shingle Oak, Laurel Oak. A large tree; wood heavy, hard, rather coarse-grained. Lvs. lanceolate-oblong, thickish, shining above, downy beneath; cup between saucer-shaped and top-shaped.

34. Ostrya. Iron-wood.

66. *O. Virginiana*, Mich.; Hop Horn-beam, Iron-wood. A small tree; bark brownish, furrowed with fine longitudinal divisions; wood heavy, very strong and hard, tough; lvs. serrate, 11–15 prominent veins; fr. hop-like in appearance.

35. Carpinus. Water Beech.

67. *C. Caroliniana*, Walter; Horn-beam, Blue Beech, Water Beech. A small tree; bark smooth, close, gray; wood heavy, very strong and hard; lvs. straight-veined, resembling the beech; fr. catkin-like, loose, the bractlets open and foliaceous.

(Order Betulaceæ.)

36. Betula. Birch.

68. *B. nigra*, Ait.; Red Birch. A large tree, with greenish-brown bark, somewhat laminate, becoming torn into shreds; wood light, rather hard, strong, close-grained; branchlets often clothing the trunk to the base; lvs. rhombic-ovate, acute at each end, dark green above, pubescent.

(Order Salicaceæ.)

37. Salix. Willow.

69. *S. nigra*, Marsh.; Black Willow. A shrub or small tree, sometimes 60 ft. high; lvs. narrowly lanceolate; smooth, except on petioles and midrib; green both sides; branches brittle, pale yellow; trunk with blackish bark. Catkins on lateral leafy branches of the season; stamens 3–6; pods mostly short, ovate.

70. *S. longifolia*, Muhl.; Longleaved Willow. Shrubby or 15°–20° high; lvs. linear or lanceolate, elongated, long acuminate, remotely toothed with projecting teeth, catkins on short lateral leafy branches; stamens 2; pods oblong-conical, obtuse.

71. *S. discolor*, Muhl.; Glaucous Willow. Rarely more than 20° high; lvs. lanceolate, ovate-lanceolate or oblong, entire at the base and apex, irregularly toothed on the sides, smooth, whitish glaucous beneath, catkins appearing before the leaves; stamens 2; ovary densely silky.

72. *S. cordata*, Muhl. var. *vestita*, Anders.; Heart-leaved Willow. A straggling shrub or small tree, recent twigs tomentose; lvs. linear-lanceolate or oblong-lanceo-

late, or on vigorous shoots broadly-lanceolate, glandular serrate, sharply toothed, smooth, veinlets reticulated and pale beneath; the sessile aments precede the leaves; stamens 2; pods long pedicelled.

38. POPULUS. POPLAR.

73. *P. monilifera*, Ait.; Cottonwood, Necklace Poplar. A large tree; wood very light, soft, not strong; lvs. broadly deltoid, prominent nerves, pointed, serrate with cartilaginous, incurved, slightly hairy, teeth.

(Order Coniferæ.)

39. JUNIPERUS. JUNIPER.

74. *J. Virginiana*, L. Red Cedar, Savin. Scale-shaped lvs. acute or acutish; wood light, soft, odorous, dull red. Fr. a small, bluish berry.

40. PINUS. PINE.

75. *P. mitis*, Mx. Yellow Pine, Spruce Pine. A tree 75°–80° high; wood heavy, hard, strong, mostly coarse-grained. Lvs. in twos or threes, from long sheaths, slender, 3′–5′ long, cones ovate or oblong conical, scales tipped with a minute prickle.

INDEX TO SCIENTIFIC AND COMMON NAMES.

Acer dasycarpum . . . 12
Acer rubrum . . . 13
Acer saccharinum . . . 11
Æsculus flava . . . 9
Æsculus glabra . . . 8
Amelanchier Canadensis . . . 29
American Ash . . . 33
American Crab-apple . . . 24
American Elm . . . 41
American Linden . . . 2
Ash, American . . . 33
Ash, Blue . . . 36
Ash, Green . . . 35
Ash-leaved Maple . . . 14
Ash, Prickly . . . 3
Ash, Red . . . 34
Ash, Wafer . . . 4
Ash, White . . . 33
Asimina triloba . . . 1
Basswood . . . 2
Bean Tree . . . 37
Beech, Blue . . . 67
Berry, June . . . 29
Berry, Service . . . 29
Betula nigra . . . 68
Big Shellbark . . . 51
Birch, Red . . . 68
Bitter-nut . . . 54
Bitter Pecan . . . 55
Black Cherry . . . 23
Black Hickory . . . 52, 53
Black Jack . . . 63
Black Locust . . . 17
Black Oak . . . 61, 62
Black Thorn . . . 27
Black Walnut . . . 48
Black Willow . . . 69
Blue Ash . . . 36
Blue Beech . . . 67
Bois d'Arc . . . 45
Box Elder . . . 14
Buckeye, Fetid . . . 8
Buckeye, Ohio . . . 8
Buckeye, Sweet . . . 9
Buckthorn, Southern . . . 31
Bull-nut . . . 52
Bumelia lanuginosa . . . 30
Bumelia lycioides . . . 31
Burning Bush . . . 6
Burr Oak . . . 58
Butternut . . . 47
Buttonwood . . . 46
Canada Plum . . . 21
Carpinus Caroliniana . . . 67
Carya alba . . . 50
Carya amara . . . 54
Carya aquatica . . . 55
Carya olivæformis . . . 49
Carya porcina . . . 53
Carya sulcata . . . 51
Carya tomentosa . . . 52
Catalpa bignonioides . . . 37
Catalpa speciosa . . . 38
Catalpa, Western . . . 38
Cedar, Red . . . 74
Celtis occidentalis . . . 43
Cercis Canadensis . . . 20
Cherry, Black . . . 23
Cherry, Indian . . . 7
Cherry, Wild . . . 23
Chicasaw Plum . . . 22
Chinquapin Oak . . . 60
Cockspur Thorn . . . 25
Coffee-Tree . . . 18
Cottonwood . . . 73
Crab Apple, American . . . 24
Cratægus coccinea . . . 26
Cratægus Crus-galli . . . 25
Cratægus tomentosa . . . 27
Cratægus tomentosa, var. punctata . . . 28

Diospyros Virginiana 32
Dwarf Sumac 15
Elder, Poison 16
Elm, American 41
Elm, Red 40
Elm, Slippery 40
Elm, Water 41
Elm, White 41
Elm, Winged 42
Euonymus atropurpureus 6
Fetid Buckeye 8
Fraxinus Americana 33
Fraxinus pubescens. 34
Fraxinus quadrangulata 36
Fraxinus viridis 35
Glaucous Willow 71
Gleditschia triacanthos 19
Green Ash. 35
Gumelastic 30
Gymnocladus Canadensis 18
Hackberry. 43
Haw, Pear 27
Haw, Red 26
Haw, Scarlet. 26
Heart-leaved Willow. 72
Hickory, Bitter-nut.. 54
Hickory, Bitter Pecan. 55
Hickory, Black 52, 53
Hickory, Pig-nut 53
Hickory, Shagbark 50
Hickory, Shellbark 51
Hickory, Swamp. 54
Hickory, Water 55
Hog Plum. 22
Holly 5
Honey Locust 19
Hop Horn-beam. 66
Hop-tree 4
Horn-beam 67
Horn-beam, Hop 66
Ilex decidua. 5
Indian Cherry. 7
Iron Oak 57
Iron-wood 66
Jack Oak 63
Judas Tree 20
June Berry 29
Juniperus Virginiana 74
Juglans cinerea 47
Juglans nigra 48
Kentucky Coffee-tree 18
King-nut 52
Laurel Oak 65
Linden 2
Locust 17
Locust, Black 17
Locust, Honey. 19
Locust, Yellow 17
Long-leaved Willow 70
Maclura aurantiaca 45
Maple, Ash-leaved. 14
Maple, Red 13
Maple, Silver 12
Maple, Soft 12
Maple, Sugar 11
Maple, White 12
Morus rubra. 44
Mulberry, Red 44
Necklace Poplar. 73
Negundo aceroides 14
Nettle-tree 43
Oak, Black 61, 62
Oak, Burr 58
Oak, Chinquapin 60
Oak, Iron 57
Oak, Jack 63
Oak, Laurel 65
Oak, Pin 64
Oak, Post 57
Oak, Quercitron 62
Oak, Red 61
Oak, Shingle. 65
Oak, Water 64
Oak, White 56
Oak, Yellow 60, 62
Ohio Buckeye 8
Osage Orange 45
Ostrya Virginiana 66
Papaw 1
Pear Haw 27
Pecan, Bitter 55
Pecan-nut 49
Persimmon 32
Pignut, Hickory. 53
Pine, Spruce. 75
Pine, Yellow 75
Pin Oak 64
Pinus mitis 75
Platanus occidentalis 46
Plum, Canada 21
Plum, Chicasaw 22
Plum, Hog. 22
Plum, Wild 21
Poison Elder 16
Poison Sumac 16
Poplar, Necklace 73
Populus monilifera 73
Post Oak 57
Prickly Ash 3
Prunus Americana 21
Prunus angustfolia 22
Prunus serotina 23
Ptelea trifoliata 4
Pyrus coronaria 24
Quercitron Oak 62
Quercus alba 56
Quercus bicolor 59
Quercus imbricaria 65
Quercus macrocarpa 58
Quercus nigra 63
Quercus obtusiloba 57
Quercus palustris 64
Quercus prinoides 60
Quercus rubra 61
Quercus tinctoria 62
Red Oak 34
Red Birch 68
Red-Bud 20

Red Cedar 74
Red Elm 40
Red Haw 26
Red Maple 13
Red Mulberry 44
Red Oak 61
Rhamnus Caroliniana 7
Rhus copallina 15
Rhus venenata 16
Robinia Pseudacacia 17
Salix cordata, var. vestita 72
Salix discolor 71
Salix longifolia 70
Salix nigra 69
Sapindus marginatus 10
Sassafras 39
Sassafras officinale 39
Savin 74
Scarlet Haw 26
Service Berry 29
Shagbark Hickory 50
Shellbark Hickory 50
Shellbark Hickory, big 51
Shingle Oak 65
Schittim-wood 30
Silver Maple 12
Slippery Elm 40
Soapberry 10
Soft Maple 11
Southern Buckthorn 31
Spruce Pine 75
Sugarberry 43
Sugar Maple 11
Sumac, Dwarf 15
Sumac, Poison 16
Swamp Hickory 54
Swamp White Oak 59
Sweet Buckeye 9
Sycamore 46
Thorn, Black 27
Thorn, Cockspur 25
Thorn, White 26
Tilia Americana 2
Ulmus alata 42
Ulmus Americana 41
Ulmus fulva 40
Wafer Ash 4
Wahoo 6, 42
Walnut, Black 48
Walnut, White 47
Water Beech 67
Water Elm 41
Water Hickory 55
Water Oak 64
Western Catalpa 38
White Ash 33
White Elm 41
White Maple 12
White Oak 56
White Oak, Swamp 59
White Thorn 26
White Walnut 47
Wild Cherry 23
Wild China 10
Wild Plum 21
Willow, Black 69
Willow, Glaucous 71
Willow, Heart-leaved 72
Willow, Long-leaved 70
Winged Elm 42
Yellow Locust 17
Yellow Oak 60, 62
Yellow Pine 75
Zanthoxylum Americanum 3

THE SKY.[1]

BY EDWARD L. NICHOLS, OF THE UNIVERSITY OF KANSAS.

Nothing in nature has impressed man more profoundly than the sky. Poet, painter, and philosopher, ancient and modern, each in his own way has striven to express its beauties. The ancient idea of the sky was that of an adamantine dome or vault upon which stars were studded, within which sun, moon, and planets moved. Upon Egyptian, Greek, and Roman, for whom the idea of an atmosphere as we now understand it did not exist, to whom the infinities of space were entirely closed, for whom there was no such thing as aërial perspective, the subtler beauties were lost. Yet from the earliest times the color of the sky drew the attention and admiration of all men, and expressions for it began to find their way into language and literature at a day when the color-sense, as we now know it, was largely undeveloped.[2]

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[1] Address of the retiring President. Delivered November 28, 1886, at the Emporia meeting of the Kansas Academy of Science.

[2] See Gladstone, Nineteenth Century, 1877, p. 367.

Diospyros Virginiana 32
Dwarf Sumac 15
Elder, Poison 16
Elm, American 41
Elm, Red 40
Elm, Slippery 40
Elm, Water 41
Elm, White 41
Elm, Winged 42
Euonymus atropurpureus 6
Fetid Buckeye 8
Fraxinus Americana 33
Fraxinus pubescens. 34
Fraxinus quadrangulata 36
Fraxinus viridis 35
Glaucous Willow 71
Gleditschia triacanthos 19
Green Ash. 35
Gumelastic 30
Gymnocladus Canadensis 18
Hackberry. 43
Haw, Pear 27
Haw, Red 26
Haw, Scarlet. 26
Heart-leaved Willow. 72
Hickory, Bitter-nut.. 54
Hickory, Bitter Pecan. 55
Hickory, Black 52, 53
Hickory, Pig-nut 53
Hickory, Shagbark 50
Hickory, Shellbark 51
Hickory, Swamp. 54
Hickory, Water 55
Hog Plum. 22
Holly 5
Honey Locust 19
Hop Horn-beam. 66
Hop-tree 4
Horn-beam 67
Horn-beam, Hop 66
Ilex decidua. 5
Indian Cherry. 7
Iron Oak 57
Iron-wood 66
Jack Oak 63
Judas Tree 20
June Berry 29
Juniperus Virginiana 74
Juglans cinerea 47
Juglans nigra 48
Kentucky Coffee-tree 18
King-nut 52
Laurel Oak 65
Linden 2
Locust 17
Locust, Black 17
Locust, Honey. 19
Locust, Yellow 17
Long-leaved Willow 70
Maclura aurantiaca 45
Maple, Ash-leaved. 14
Maple, Red 13
Maple, Silver 12
Maple, Soft 12
Maple, Sugar 11
Maple, White 12
Morus rubra. 44
Mulberry, Red 44
Necklace Poplar. 73
Negundo aceroides 14
Nettle-tree 43
Oak, Black 61, 62
Oak, Burr 58
Oak, Chinquapin 60
Oak, Iron 57
Oak, Jack 63
Oak, Laurel 65
Oak, Pin 64
Oak, Post 57
Oak, Quercitron 62
Oak, Red 61
Oak, Shingle. 65
Oak, Water 64
Oak, White 56
Oak, Yellow 60, 62
Ohio Buckeye 8
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Ostrya Virginiana 66
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of these two ideas led to the distinction between the heavens outside of and the sky lying within our atmosphere. The rise of the distinction manifests itself on the one hand in painting; for whereas the early painters portrayed the sky as the ancients saw it, a vaulted dome of blue, hard and without depth, the growth of the art has been marked throughout by more and more successful attempts at atmospheric effect, at intangibility and depth. Where the earlier artists saw and painted only a blue surface, members of later schools — the landscape painters above all — began to indicate the truths of aërial perspective which had already forced themselves upon the attention of observing men, while it remained for a Turner and a Ruskin to give, with brush and pen, that fuller expression of the subtler beauties of the sky which increasing knowledge and the æsthetic training of generations have made possible to art.

In this, as in other ways, the development of science and of art have gone hand in hand, and it would be easy to trace the influence of Tycho Brahe and Galileo, of Otto von Guericke and Newton, upon the growth of æsthetics.

Of theories of the cause of the most obvious characteristic of the sky — its blueness — there have been no lack since men began to speculate. There was, however, no basis for intelligent theorizing until the experiments of Torricelli and von Guericke had shown the existence of an atmosphere, and the great chain of truths made clear by their investigations had had time to become familiar to the common mind. Even then there was no intelligible theory of colors, and the world must needs wait for Newton's prism before it could deal successfully with the problem of the color of the sky. The host of hypotheses which had been formed during the Middle Ages, were based upon so crude a conception of the nature of color that they melted instantly before the flood of light which was poured into the world of optics by Newton's analysis of the sunbeam. In the words inscribed upon a tablet at his birthplace —

> "Nature and Nature's laws lay hid in night;
> God said 'Let Newton be,' and all was light."[1]

A glance at these theories of the Middle Ages shows, nevertheless, how true it is that "the dream of one age is the science of the next," for it is easy to pick out from amid the debris of ruined structures fore-gleams of almost every theory which has appeared since Newton's time. Thus Leonardo da Vinci, in whom the highest attributes of the philosopher and artist were united in such a remarkable degree, regarded the azure as an optical illusion, or at least as subjective. Honoratus Fabri claimed that the color of the sky was due to reflexion from particles floating in the air, and this at a time when the existence of the atmosphere as we now know it had not been established. Fromond, and later, Funccius,[2] who wrote an entire work upon this subject, derived the color of the sky from a mixture of "much darkness and little light," and this opinion was long the ruling one. Otto von Guericke,[3] also, whose invention of the air-pump did much to further positive knowledge of the atmosphere, contended that black and white really give blue by mixture; and he described in evidence a variety of curious phenomena which the science of that day was not in position to explain.

At last these centuries of fruitless floundering in the dark came to an end. Newton's analysis of the sunbeam with the prism furnished the needed foundation for consistent theories in chromatics, and the problem of the color of the sky at once resolved itself into that of the action of the atmosphere upon the sunlight penetrating it. His method and its results alike are now the property of every schoolboy,

[1] Sir David Brewster's Life of Sir Isaac Newton, p. 305.
[2] See Fischer; Geschichte der Physik. Vol. II, p. 149.
[3] Von Guericke; Nova Experiment. Magdeb. Lib. IV, cap. XII, p. 147.

but it is with never-failing pleasure that lovers of nature to-day look back upon the experiments of that young philosopher, fellow of Cambridge, just turned twenty-four, whose mechanical ingenuity from boyhood and love of mathematics had already attracted favorable attention. Having bought a prism in the town, he took it home to his rooms to study the laws of refraction. The chamber was darkened, and the prism was placed in a ray of sunlight, which entered through a small, round hole cut in the shutter for that purpose. The diverted rays fell upon the wall, and then, for the first time recorded in the annals of science, was spread out that magnificent band of color — the solar spectrum. To understand Newton's mingled surprise and delight, we must remember that the only recognized function of the prism at that time was its power to bend a ray of light in accordance with Snell's law of refraction. The complex character of sunlight was unsuspected, dispersion undreamed of; nor did the truth dawn in Newton's mind at once. The unexpected display of color he attributed, as was in keeping with the teaching of the day, to some subtle action of the glass, and, having procured a second prism, he tried to increase the effect by passing the ray through it also. The further divergence of the spectral tints and their reunion in the original white of the sunbeam, according to the positions of the prisms, afforded the necessary hint, and Newton advanced by rapid strides to two epoch-making discoveries: That sunlight is the mixture of a vast number of colored rays differing from each other by insensible gradations of hue; and that these colors, being differently refracted, may be separated (dispersed) by the prism.

To appreciate the complete novelty of these results and the effects they were destined to produce upon the science of that day, we must remember that optics was in its very infancy; that the telescope itself, but little changed from the early forms devised by Galileo and the Dutch opticians, had been known but half a century, and that the first important step in its improvement was at this very time about to be taken by Newton himself. Although it was a period of great scientific activity, embracing such names as Gregory, Hooke, Sir Christopher Wren, and Boyle in England, and La Place, Leibnitz, Hugghens, and Bernouilli on the continent, the system of natural philosophy still in vogue was the Cartesian, the absurdities of which, day by day more manifest, were nevertheless inadequate to dethrone it until these and other remarkable advances had taken root, and the Newtonian philosophy, nearly half a century later, had finally become established in the universities. It was the beginning of a struggle against the extreme dogmatism of the period — a struggle which was to end in the introduction of experimental demonstrations, and so in the planting of the germ from which have sprung the great laboratory systems of the present time.

Starting from the complex character of sunlight as a foundation, the science of color in the hands of Newton and his followers made rapid progress, until the various ways in which, in nature, certain components of sunlight become isolated and appear as color, have become well known. We are thus able to divide all colors into two great classes — objective and subjective, and have learned that objective colors are formed either by the absorption of other rays or by interference; while subjective colors are due to physiological processes by means of which the eye is rendered more sensitive to certain colors than to the other components of the light which reaches the retina.

The blue of the sky is due, then, to absorption or to interference, or it is of subjective character. Newton[1] himself thought it due to interference, but it is cus-

[1] Newton; Optice, London, 1706.

bark, lvs. and pods bitter and aromatic; lfts. 9–11; fls. in axillary clusters, preceding the lvs. in spring; stems, and often leaf-stalks, prickly.

4. PTELEA. WAFER ASH.

4. *P. trifoliata*, L.; Hoptree, Wafer Ash. A small tree, often only a shrub; lvs. 3-foliate; lfts. sessile, ovate, pointed; small greenish-white fls. The bitter fruit winged all around, nearly 1′ in diameter.

(Order Aquifoliaceæ.)

5. ILEX. HOLLY.

5. *I. decidua*, Walter; Holly. A tree or tall, straggling shrub; wood hard, creamy white; lvs. simple, alternate, downy on the midrib, shining above, acute or acuminate at each end. Small fls. in spring; fr. a red drupe.

(Order Celastraceæ.)

6. EUONYMUS. BURNING BUSH.

6. *E. atropurpureus*, Jacq.; Burning Bush, Wahoo. Small tree, often a low shrub; wood heavy, tinged with orange; lvs. opposite, serrate, pointed; branchlets 4-sided; pods deeply lobed, bright crimson in autumn.

(Order Rhamnaceæ.)

7. RHAMNUS.

7. *R. Caroliniana*, Walter; Indian Cherry. Small tree; wood light brown, hard; lvs. alternate (rarely opposite), oblong-oval, dark shining green above; veins prominent, nearly straight, parallel. Fr. a black, berry-like drupe.

(Order Sapindaceæ.)

8. ÆSCULUS. BUCKEYE.

8. *A. glabra*, Willd.; Ohio Buckeye, Fetid Buckeye. Small tree, with light, soft wood. Lfts. 5; fls. in May or June; stamens curved, exserted; fr. covered with prickles when young.

9. *A. flava*, Ait.; Sweet Buckeye. Tree and wood similar to preceding. Lfts. 5–7; fls. in late spring; stamens included; fr. smooth.

9. SAPINDUS. SOAPBERRY.

10. *S. marginatus*, Willd.; Soapberry, Wild China. A tree 20°–50° high. Lfts. 9–18, ovate-lanceolate, long-pointed, entire. Berry usually single, reddish-brown; pulp soapy.

(Order Aceraceæ.)

10. ACER. MAPLE.

11. *A. saccharinum*, Wang; Sugar Maple. A large tree; bark light gray; wood heavy, hard, tough, close-grained; lvs. 3–5-lobed, whitish beneath, sinuses rounded; fls. appearing with the lvs.; fr. broad.

12. *A. dasycarpum*, Ehrh.; Soft, White, or Silver Maple. A large tree; wood light, hard, brittle, close-grained. Lvs. very deeply 5-lobed, silvery-white underneath, the divisions narrow, cut-lobed and toothed; fls. preceding the lvs.; fr. woolly when young.

13. *A. rubrum*, L.; Red Maple. Large tree, wood heavy, hard, not strong, compact; twigs reddish; lvs. 3–5-lobed, whitish underneath, the lobes serrate and notched; fls. preceding the lvs.; fr. smooth.

11. NEGUNDO. BOX ELDER, ASH-LEAVED MAPLE.

14. *N. aceroides*, Mœnch.; Box Elder. Tree 25°–50° high; wood light, soft; lvs. ternate, and 5–7-pinnate, terminal lft. largest.

(Order Anacardiaceæ.)

12. RHUS. SUMACH.

15. *R. copallina*, L.; Dwarf Sumac. A small tree or only a shrub. Lfts. 9–21, ovate-lanceolate, petioles winged between the lfts.; branches and petioles pubescent; fruit hairy.

16. *R. venenata*, L.; Poison Sumac, Poison Elder. A small tree, lfts. 7–13, ovate-oblong, petioles wingless; fr. glabrous, whitish, smooth. Whole plant poisonous to taste or touch.

(Order Leguminosæ.)

13. ROBINIA. LOCUST.

17. *R. Pseudacacia*, L.; Black Locust, Yellow Locust. Small or medium-sized tree; prickly or spiny; wood heavy, hard; lfts. 6–12 pairs; fls. fragrant, showy, in numerous pendulous clusters; pod 4′–5′ long.

14. GYMOCLADUS. COFFEE-TREE.

18. *G. Canadensis*, Lam.; Kentucky Coffee-Tree. A large tree; wood strong and heavy, but not hard; branches naked; lvs. very large, bi-pinnate; pods containing several brown, hard, polished seeds.

15. GLEDITSCHIA. HONEY LOCUST.

19. *G. triacanthos*, L.; Black, Sweet, or Honey Locust. A large tree, with strong, heavy, hard wood; branches armed with stout, triple or branched thorns; pods flat, often twisted.

16. CERCIS. RED-BUD.

20. *C. Canadensis*, L.; Red-bud, Judas tree. Small tree, with hard, heavy, but not strong wood. Lvs. broadly ovate-cordate, entire, acuminate, smooth, but villous on the veins beneath; showy red flowers preceding the leaves.

(Order Rosaceæ.)

17. PRUNUS.* PLUM OR CHERRY.

21. *P. Americana*, Marsh.; Wild or Canada Plum. A small, thorny tree; wood heavy, hard, strong; lvs. conspicuously pointed, ovate or somewhat obovate, coarsely or doubly serrate, very veiny; flowers in early spring.

22. *P. angustifolia*, Marsh.; Hog Plum, Chicasaw Plum. A small tree or low shrub, scarcely thorny; wood heavy, soft, not strong; lvs. nearly lanceolate, acute, finely serrulate; flowers in early spring.

23. *P. serotina*, Ehrh; Wild Black Cherry. Large tree, branches reddish-brown; wood light, hard, strong; lvs. oblong, taper-pointed, serrate, with incurved, callous teeth; fls. in racemes, late in spring; fr. purplish black.

18. PYRUS. APPLE.

24. *P. coronaria*, L.; American Crab Apple. A small tree; lvs. ovate, somewhat cordate at base, cut-serrate, or lobed; fls. handsome, fragrant; fr. greenish.

19. CRATÆGUS. THORN.

Lvs. with a tapering base, and cut or serrate above the middle (*a*).

Lvs. toothed, cut or cut-lobed (*b*).

a. Lvs. shining above, serrate toward the apex (25).

a. Lvs. dull, unequally toothed above (28).

b. Glabrous; lvs. thin, usually abrupt at base (26).

b. Pubescent; lvs. thickish; petioles slightly margined (27).

*P. *Virginiana* L., Choke Cherry, with lvs. oval, oblong or obovate, abruptly pointed, very sharply serrate with slender teeth, and fr. red turning to dark crimson, though excluded by Prof. Sargent, is sometimes arborescent with us.

(Order Platanaceæ.)

30. PLATANUS. SYCAMORE.

46. *P. occidentalis*, L.; Sycamore, Buttonwood. A large tree; wood light, soft, close-grained; bark (at least of branches) white, detached annually in thin plates; lvs. mostly truncate at base, sinuate-lobed or toothed.

(Order Juglandaceæ.)

31. JUGLANS. WALNUT.

47. *J. cinerea*, L.; Butternut, White Walnut. 50°–100° high; wood light, soft; lfts. 15–17, oblong-lanceolate; fr. oblong, clammy, pointed; the nut deeply sculptured and rough, with ragged ridges.

48. *J. nigra*, L.; Black Walnut. 90°–140° high; wood heavy, hard; lfts. 15–21, ovate-lanceolate; fr. spherical, roughly dotted, nut corrugated.

32. CARYA. HICKORY.

Lfts. 13–15, scythe-shaped; nut oblong, thin-shelled, sweet (49).
Lfts. 7–11; nut with a tender shell and bitter kernel (*a*).
Lfts. 5–9; nut roundish, hard-shelled, sweet (*b*).

a. Lfts. sharply serrate; nut globular, white; lvs. nearly smooth (54).
a. Lfts. subentire; nut angular, reddish; lvs. shining green both sides (55).
b. Valves of the epicarp distinct to the base; bark with loose plates (*c*).
b. Valves of the epicarp united below; bark continuous, firm (*d*).
c. Lfts. 5; shell thin (50).
c. Lfts. 7–9; shell very thick (51).
d. Lfts. 7–9, obscurely-serrate or entire, rough downy beneath (52).
d. Lfts. 5–7, serrate, nearly glabrous (53).

49. *C. olivæformis*, Nutt.; Pecan-nut. 90°–160° high; wood heavy, hard, brittle; lfts. oblong-lanceolate, 13–15, serrate, scythe-shaped. Nut thin-shelled, olive-shaped.

50. *C. alba*, Nutt.; Shagbark or Shellbark Hickory. 60°–140° high; bark exfoliating, that is, shaggy; wood heavy, hard, strong, tough; lfts. 5, lower pair much smaller; nut white; flattish-globular, shell thinnish.

51. *C. sulcata*, Nutt.; Big Shellbark. 60°–95° high; bark shaggy; wood heavy, hard, strong and tough; lfts. 7–9, downy underneath; fr. oval or ovate, 4-ribbed above the middle; husk very thick; nut large ($1\frac{1}{2}'$–$2'$ long), dull white, thick-walled.

52. *C. tomentosa*, Nutt.; Black Hickory, Bull-nut, King-nut. Bark close, rough, but not shaggy; wood very hard, heavy, strong, tough; shoots tomentose when young. Lfts. 7–9, lance-obovate. Husk very thick and hard; nut 4-ridged towards the summit, brownish; $1'$ in diameter, or smaller.

53. *C. porcina*, Nutt.; Pignut, Black Hickory. Large tree; bark not exfoliating; wood heavy, hard, very strong; lfts. 5–7, serrate, nearly glabrous; nut oblong or oval, $1\frac{1}{2}'$–$2'$ long; shell bony, thick.

54. *C. amara*, Nutt.; Bitter-nut, Swamp Hickory. 50°–80° high; bark not exfoliating; wood heavy, hard, tough; shoots and lvs. more or less pubescent, becoming almost glabrous. Lfts. 7–11, oblong-lanceolate, or lanceolate; fr. globular, 6-ridged; nut white, bitter, thin-walled, barely $1'$ long.

55. *C. aquatica*, Nutt.; Water Hickory, Bitter Pecan. 50°–65° high; wood heavy, soft, strong, rather brittle. Lfts. about 11, lanceolate, almost entire, shining green on both sides; nut small, reddish, shell very tender, kernel bitter.

(Order Cupuliferæ.)

33. QUERCUS. OAK.

Acorns on wood of the season; *i. e.*, perfected the first year (*a*).

Acorns on wood of previous season; *i. e.*, perfected the second year (*f*).

a. Lvs. lyrate or pinnatifid (*b*).

a. Lvs. coarsely toothed but not lobed (*e*).

b. Lvs. wedge-shaped at base; fruiting peduncle much longer than petiole (59).

b. Lvs., etc., not as above (*c*).

c. Cup deep, scales pointed, upper ones awned, mostly mossy-bordered (58).

c. Cup hemispherical or saucer-shaped, not mossy-fringed (*d*).

d. Lvs. bright green above; cup rough or tubercled, much shorter than acorn (56).

d. Lvs. pale and rough above; cup not tubercled, ⅓ or ½ length of acorn (57).

e. Fruiting peduncle longer than petiole, lvs. wedge-shaped at base (59).

e. Fruiting peduncle shorter than petiole, lvs. obtuse at base (60).

f. Lvs. entire, lance-oblong, shining above, downy underneath (65).

f. Lvs. widening above, 3 or 5-lobed, sometimes with one or two lateral, bristle-tipped teeth, rusty beneath, shining above, 4′–9′ long (63).

f. Lvs. pinnatifid or lobed, not coriaceous, teeth or lobes bristle-pointed (*g*).

g. Cup saucer-shaped, very much shorter than the acorn (*h*).

g. Cup hemispherical, with a conical base, half covering the acorn (62).

h. Cup 9–12 lines broad; acorn 1′ or less long; lvs. rarely deeply pinnatifid (61).

h. Cup 5–7 lines broad; acorn 5–7 lines long; lvs. deeply pinnatifid, lobes divergent (64).

56. *Q. alba*, L.; White Oak. A large tree; wood strong, very heavy, hard, tough, brown in color; mature lvs. smooth, pale or glaucous beneath, bright green above, obovate-oblong, 3–9 obtuse lobes; cup saucer-shaped, rough, much shorter than the acorn, which is ovoid or oblong, and about 1′ long.

57. *Q. obtusiloba*, Mx.; Post Oak, Iron Oak. Rarely exceeding 75 feet in height; wood heavy, hard; lvs. grayish or yellowish downy beneath, pale and rough above, 5–7 rounded, divergent lobes; cup deep, saucer-shaped, smooth, ⅓ or ½ the length of the acorn, which is ovoid, and 6–9 lines long.

58. *Q. macrocarpa*, Mx.; Burr Oak. A large tree; wood heavy, hard, strong, tough; lvs. obovate or oblong, lyrate or deeply sinuate-lobed, or nearly parted; downy or pale beneath; cup deep, thick, scales pointed, upper ones awned and "mossy;" acorn half or entirely immersed in the cup, broadly ovoid, 1′–1½′ long.

59. *Q. bicolor*, Willd.; Swamp White Oak. A large tree; wood heavy, hard, strong, tough; lvs. obovate or oblong-obovate, cuneate at base, coarsely sinuate-crenate, soft, downy and hoary beneath, main primary veins 6–8 pairs; fruiting peduncle much longer than the petiole; cup hemispherical, half the length of acorn, which is scarcely 1′ long; scales pointed, sometimes "mossy."

60. *Q. prinoides*, Willd.; Yellow Oak, Chinquapin Oak. A large tree, or reduced to a shrub; wood heavy, hard, very strong; lvs. oblong or lanceolate, undulately sharp, crenate-toothed, minutely downy beneath; the main primary veins 10–16 pairs; fruiting peduncles shorter than the petioles; cup hemispherical, thin; acorn 7–9 lines long.

61. *Q. rubra*, L.; Red Oak, Black Oak. A large tree; wood heavy, hard, strong; lvs. glabrous, or nearly so, rather thin, oval or obovate-oblong, (rarely deeply) pinnatifid, lobes rather acute; cup saucer-shaped or flat, with a narrow raised border, 9–12 lines in diameter, very much shorter than the oblong-ovoid, 1′-long acorn.

62. *Q. tinctoria*, Bartram; Black, Yellow, or Quercitron Oak. A large tree; wood heavy, hard, strong, not tough, coarse-grained. Lvs. glabrous or nearly so (pubescent beneath when young), oval or obovate-oblong, lobes oblong, obtuse, mucronate. Cup thick, 9 lines in diameter, covering half the acorn, which is broadly or globular-ovoid.

63. *Q. nigra*, L.; Black Jack, Jack Oak. A small tree; wood heavy, hard, strong. Lvs. broadly wedge-shaped (sometimes rounded at base), widely dilated and 3 (rarely 5) lobed at summit; rusty pubescent beneath, shining above; cup top-shaped; acorn short ovoid.

64. *Q. palustris*, Du Roi.; Pin Oak, Water Oak. A large or middle-sized tree; wood heavy, hard, very strong, coarse-grained. Lvs. glabrous or nearly so, oval or oblong-obovate, deeply pinnatifid with divergent lobes and broad, rounded sinuses; cup flat, saucer-shaped, very much shorter than the acorn, which is ovoid-globose, 5–7 lines long.

65. *Q. imbricaria*, Mx.; Shingle Oak, Laurel Oak. A large tree; wood heavy, hard, rather coarse-grained. Lvs. lanceolate-oblong, thickish, shining above, downy beneath; cup between saucer-shaped and top-shaped.

34. Ostrya. Iron-wood.

66. *O. Virginiana*, Mich.; Hop Horn-beam, Iron-wood. A small tree; bark brownish, furrowed with fine longitudinal divisions; wood heavy, very strong and hard, tough; lvs. serrate, 11–15 prominent veins; fr. hop-like in appearance.

35. Carpinus. Water Beech.

67. *C. Caroliniana*, Walter; Horn-beam, Blue Beech, Water Beech. A small tree; bark smooth, close, gray; wood heavy, very strong and hard; lvs. straight-veined, resembling the beech; fr. catkin-like, loose, the bractlets open and foliaceous.

(Order Betulaceæ.)

36. Betula. Birch.

68. *B. nigra*, Ait.; Red Birch. A large tree, with greenish-brown bark, somewhat laminate, becoming torn into shreds; wood light, rather hard, strong, close-grained; branchlets often clothing the trunk to the base; lvs. rhombic-ovate, acute at each end, dark green above, pubescent.

(Order Salicaceæ.)

37. Salix. Willow.

69. *S. nigra*, Marsh.; Black Willow. A shrub or small tree, sometimes 60 ft. high; lvs. narrowly lanceolate; smooth, except on petioles and midrib; green both sides; branches brittle, pale yellow; trunk with blackish bark. Catkins on lateral leafy branches of the season; stamens 3–6; pods mostly short, ovate.

70. *S. longifolia*, Muhl.; Longleaved Willow. Shrubby or 15°–20° high; lvs. linear or lanceolate, elongated, long acuminate, remotely toothed with projecting teeth, catkins on short lateral leafy branches; stamens 2; pods oblong-conical, obtuse.

71. *S. discolor*, Muhl.; Glaucous Willow. Rarely more than 20° high; lvs. lanceolate, ovate-lanceolate or oblong, entire at the base and apex, irregularly toothed on the sides, smooth, whitish glaucous beneath, catkins appearing before the leaves; stamens 2; ovary densely silky.

72. *S. cordata*, Muhl. var. *vestita*, Anders.; Heart-leaved Willow. A straggling shrub or small tree, recent twigs tomentose; lvs. linear-lanceolate or oblong-lanceo-

late, or on vigorous shoots broadly-lanceolate, glandular serrate, sharply toothed, smooth, veinlets reticulated and pale beneath; the sessile aments precede the leaves; stamens 2; pods long pedicelled.

38. POPULUS. POPLAR.

73. *P. monilifera*, Ait.; Cottonwood, Necklace Poplar. A large tree; wood very light, soft, not strong; lvs. broadly deltoid, prominent nerves, pointed, serrate with cartilaginous, incurved, slightly hairy, teeth.

(Order Coniferæ.)

39. JUNIPERUS. JUNIPER.

74. *J. Virginiana*, L. Red Cedar, Savin. Scale-shaped lvs. acute or acutish; wood light, soft, odorous, dull red. Fr. a small, bluish berry.

40. PINUS. PINE.

75. *P. mitis*, MX. Yellow Pine, Spruce Pine. A tree 75°–80° high; wood heavy, hard, strong, mostly coarse-grained. Lvs. in twos or threes, from long sheaths, slender, 3′–5′ long, cones ovate or oblong conical, scales tipped with a minute prickle.

INDEX TO SCIENTIFIC AND COMMON NAMES.

Acer dasycarpum 12
Acer rubrum 13
Acer saccharinum 11
Æsculus flava 9
Æsculus glabra 8
Amelanchier Canadensis 29
American Ash 33
American Crab-apple 24
American Elm 41
American Linden 2
Ash, American 33
Ash, Blue 36
Ash, Green 35
Ash-leaved Maple 14
Ash, Prickly 3
Ash, Red 34
Ash, Wafer 4
Ash, White 33
Asimina triloba 1
Basswood 2
Bean Tree 37
Beech, Blue 67
Berry, June 29
Berry, Service 29
Betula nigra 68
Big Shellbark 51
Birch, Red 68
Bitter-nut 54
Bitter Pecan 55
Black Cherry 23
Black Hickory 52, 53
Black Jack 63
Black Locust 17
Black Oak 61, 62
Black Thorn 27
Black Walnut 48
Black Willow 69
Blue Ash 36
Blue Beech 67
Bois d'Arc 45
Box Elder 14
Buckeye, Fetid 8
Buckeye, Ohio 8
Buckeye, Sweet 9
Buckthorn, Southern 31
Bull-nut 52
Bumelia lanuginosa 30
Bumelia lycioides 31
Burning Bush 6
Burr Oak 58
Butternut 47
Buttonwood 46
Canada Plum 21
Carpinus Caroliniana 67
Carya alba 50
Carya amara 54
Carya aquatica 55
Carya olivæformis 49
Carya porcina 53
Carya sulcata 51
Carya tomentosa 52
Catalpa bignonioides 37
Catalpa speciosa 38
Catalpa, Western 38
Cedar, Red 74
Celtis occidentalis 43
Cercis Canadensis 20
Cherry, Black 23
Cherry, Indian 7
Cherry, Wild 23
Chicasaw Plum 22
Chinquapin Oak 60
Cockspur Thorn 25
Coffee-Tree 18
Cottonwood 73
Crab Apple, American 24
Cratægus coccinea 26
Cratægus Crus-galli 25
Cratægus tomentosa 27
Cratægus tomentosa, var. punctata 28

Diospyros Virginiana 32
Dwarf Sumac 15
Elder, Poison 16
Elm, American 41
Elm, Red 40
Elm, Slippery 40
Elm, Water 41
Elm, White 41
Elm, Winged 42
Euonymus atropurpureus 6
Fetid Buckeye 8
Fraxinus Americana 33
Fraxinus pubescens. 34
Fraxinus quadrangulata 36
Fraxinus viridis 35
Glaucous Willow 71
Gleditschia triacanthos 19
Green Ash. 35
Gumelastic 30
Gymnocladus Canadensis 18
Hackberry. 43
Haw, Pear 27
Haw, Red 26
Haw, Scarlet. 26
Heart-leaved Willow. 72
Hickory, Bitter-nut.. 54
Hickory, Bitter Pecan. 55
Hickory, Black 52, 53
Hickory, Pig-nut 53
Hickory, Shagbark 50
Hickory, Shellbark 51
Hickory, Swamp. 54
Hickory, Water 55
Hog Plum. 22
Holly 5
Honey Locust 19
Hop Horn-beam. 66
Hop-tree 4
Horn-beam 67
Horn-beam, Hop 66
Ilex decidua. 5
Indian Cherry. 7
Iron Oak 57
Iron-wood 66
Jack Oak 63
Judas Tree 20
June Berry 29
Juniperus Virginiana 74
Juglans cinerea 47
Juglans nigra 48
Kentucky Coffee-tree 18
King-nut 52
Laurel Oak 65
Linden 2
Locust 17
Locust, Black 17
Locust, Honey. 19
Locust, Yellow 17
Long-leaved Willow 70
Maclura aurantiaca 45
Maple, Ash-leaved. 14
Maple, Red 13
Maple, Silver 12
Maple, Soft 12
Maple, Sugar 11
Maple, White 12
Morus rubra. 44
Mulberry, Red 44
Necklace Poplar. 73
Negundo aceroides 14
Nettle-tree 43
Oak, Black 61, 62
Oak, Burr 58
Oak, Chinquapin 60
Oak, Iron 57
Oak, Jack 63
Oak, Laurel 65
Oak, Pin 64
Oak, Post 57
Oak, Quercitron 62
Oak, Red 61
Oak, Shingle. 65
Oak, Water 64
Oak, White 56
Oak, Yellow 60, 62
Ohio Buckeye 8
Osage Orange 45
Ostrya Virginiana 66
Papaw 1
Pear Haw 27
Pecan, Bitter 55
Pecan-nut 49
Persimmon 32
Pignut, Hickory. 53
Pine, Spruce. 75
Pine, Yellow 75
Pin Oak 64
Pinus mitis 75
Platanus occidentalis 46
Plum, Canada 21
Plum, Chicasaw 22
Plum, Hog. 22
Plum, Wild 21
Poison Elder 16
Poison Sumac 16
Poplar, Necklace 73
Populus monilifera 73
Post Oak 57
Prickly Ash 3
Prunus Americana 21
Prunus angustfolia 22
Prunus serotina 23
Ptelea trifoliata 4
Pyrus coronaria 24
Quercitron Oak 62
Quercus alba 56
Quercus bicolor 59
Quercus imbricaria 65
Quercus macrocarpa 58
Quercus nigra 63
Quercus obtusiloba 57
Quercus palustris 64
Quercus prinoides 60
Quercus rubra 61
Quercus tinctoria 62
Red Oak 34
Red Birch 68
Red-Bud 20

Red Cedar 74
Red Elm 40
Red Haw 26
Red Maple 13
Red Mulberry 44
Red Oak 61
Rhamnus Caroliniana 7
Rhus copallina 15
Rhus venenata 16
Robinia Pseudacacia 17
Salix cordata, var. vestita 72
Salix discolor 71
Salix longifolia 70
Salix nigra 69
Sapindus marginatus 10
Sassafras 39
Sassafras officinale 39
Savin 74
Scarlet Haw 26
Service Berry 29
Shagbark Hickory 50
Shellbark Hickory 50
Shellbark Hickory, big 51
Shingle Oak 65
Schittim-wood 30
Silver Maple 12
Slippery Elm 40
Soapberry 10
Soft Maple 11
Southern Buckthorn 31
Spruce Pine 75
Sugarberry 43
Sugar Maple 11
Sumac, Dwarf 15
Sumac, Poison 16
Swamp Hickory 54
Swamp White Oak 59
Sweet Buckeye 9
Sycamore 46
Thorn, Black 27
Thorn, Cockspur 25
Thorn, White 26
Tilia Americana 2
Ulmus alata 42
Ulmus Americana 41
Ulmus fulva 40
Wafer Ash 4
Wahoo 6, 42
Walnut, Black 48
Walnut, White 47
Water Beech 67
Water Elm 41
Water Hickory 55
Water Oak 64
Western Catalpa 38
White Ash 33
White Elm 41
White Maple 12
White Oak 56
White Oak, Swamp 59
White Thorn 26
White Walnut 47
Wild Cherry 23
Wild China 10
Wild Plum 21
Willow, Black 69
Willow, Glaucous 71
Willow, Heart-leaved 72
Willow, Long-leaved 70
Winged Elm 42
Yellow Locust 17
Yellow Oak 60, 62
Yellow Pine 75
Zanthoxylum Americanum 3

THE SKY.[1]

BY EDWARD L. NICHOLS, OF THE UNIVERSITY OF KANSAS.

Nothing in nature has impressed man more profoundly than the sky. Poet, painter, and philosopher, ancient and modern, each in his own way has striven to express its beauties. The ancient idea of the sky was that of an adamantine dome or vault upon which stars were studded, within which sun, moon, and planets moved. Upon Egyptian, Greek, and Roman, for whom the idea of an atmosphere as we now understand it did not exist, to whom the infinities of space were entirely closed, for whom there was no such thing as aërial perspective, the subtler beauties were lost. Yet from the earliest times the color of the sky drew the attention and admiration of all men, and expressions for it began to find their way into language and literature at a day when the color-sense, as we now know it, was largely undeveloped.[2]

The modern idea supplanted the old when the conception of an atmosphere became well established, and when modern astronomy had begun to give proper notions of the enormous distances and true motions of the heavenly orbs. The development

[1] Address of the retiring President. Delivered November 28, 1886, at the Emporia meeting of the Kansas Academy of Science.

[2] See Gladstone, Nineteenth Century, 1877, p. 367.

of these two ideas led to the distinction between the heavens outside of and the sky lying within our atmosphere. The rise of the distinction manifests itself on the one hand in painting; for whereas the early painters portrayed the sky as the ancients saw it, a vaulted dome of blue, hard and without depth, the growth of the art has been marked throughout by more and more successful attempts at atmospheric effect, at intangibility and depth. Where the earlier artists saw and painted only a blue surface, members of later schools — the landscape painters above all — began to indicate the truths of aërial perspective which had already forced themselves upon the attention of observing men, while it remained for a Turner and a Ruskin to give, with brush and pen, that fuller expression of the subtler beauties of the sky which increasing knowledge and the æsthetic training of generations have made possible to art.

In this, as in other ways, the development of science and of art have gone hand in hand, and it would be easy to trace the influence of Tycho Brahe and Galileo, of Otto von Guericke and Newton, upon the growth of æsthetics.

Of theories of the cause of the most obvious characteristic of the sky — its blueness — there have been no lack since men began to speculate. There was, however, no basis for intelligent theorizing until the experiments of Torricelli and von Guericke had shown the existence of an atmosphere, and the great chain of truths made clear by their investigations had had time to become familiar to the common mind. Even then there was no intelligible theory of colors, and the world must needs wait for Newton's prism before it could deal successfully with the problem of the color of the sky. The host of hypotheses which had been formed during the Middle Ages, were based upon so crude a conception of the nature of color that they melted instantly before the flood of light which was poured into the world of optics by Newton's analysis of the sunbeam. In the words inscribed upon a tablet at his birthplace —

> "Nature and Nature's laws lay hid in night;
> God said 'Let Newton be,' and all was light." [1]

A glance at these theories of the Middle Ages shows, nevertheless, how true it is that "the dream of one age is the science of the next," for it is easy to pick out from amid the debris of ruined structures fore-gleams of almost every theory which has appeared since Newton's time. Thus Leonardo da Vinci, in whom the highest attributes of the philosopher and artist were united in such a remarkable degree, regarded the azure as an optical illusion, or at least as subjective. Honoratus Fabri claimed that the color of the sky was due to reflexion from particles floating in the air, and this at a time when the existence of the atmosphere as we now know it had not been established. Fromond, and later, Funccius,[2] who wrote an entire work upon this subject, derived the color of the sky from a mixture of "much darkness and little light," and this opinion was long the ruling one. Otto von Guericke,[3] also, whose invention of the air-pump did much to further positive knowledge of the atmosphere, contended that black and white really give blue by mixture; and he described in evidence a variety of curious phenomena which the science of that day was not in position to explain.

At last these centuries of fruitless floundering in the dark came to an end. Newton's analysis of the sunbeam with the prism furnished the needed foundation for consistent theories in chromatics, and the problem of the color of the sky at once resolved itself into that of the action of the atmosphere upon the sunlight penetrating it. His method and its results alike are now the property of every schoolboy,

[1] Sir David Brewster's Life of Sir Isaac Newton, p. 305.
[2] See Fischer; Geschichte der Physik. Vol. II, p. 149.
[3] Von Guericke; Nova Experiment. Magdeb. Lib. IV, cap. XII, p. 147.

but it is with never-failing pleasure that lovers of nature to-day look back upon the experiments of that young philosopher, fellow of Cambridge, just turned twenty-four, whose mechanical ingenuity from boyhood and love of mathematics had already attracted favorable attention. Having bought a prism in the town, he took it home to his rooms to study the laws of refraction. The chamber was darkened, and the prism was placed in a ray of sunlight, which entered through a small, round hole cut in the shutter for that purpose. The diverted rays fell upon the wall, and then, for the first time recorded in the annals of science, was spread out that magnificent band of color — the solar spectrum. To understand Newton's mingled surprise and delight, we must remember that the only recognized function of the prism at that time was its power to bend a ray of light in accordance with Suell's law of refraction. The complex character of sunlight was unsuspected, dispersion undreamed of; nor did the truth dawn in Newton's mind at once. The unexpected display of color he attributed, as was in keeping with the teaching of the day, to some subtle action of the glass, and, having procured a second prism, he tried to increase the effect by passing the ray through it also. The further divergence of the spectral tints and their reunion in the original white of the sunbeam, according to the positions of the prisms, afforded the necessary hint, and Newton advanced by rapid strides to two epoch-making discoveries: That sunlight is the mixture of a vast number of colored rays differing from each other by insensible gradations of hue; and that these colors, being differently refracted, may be separated (dispersed) by the prism.

To appreciate the complete novelty of these results and the effects they were destined to produce upon the science of that day, we must remember that optics was in its very infancy; that the telescope itself, but little changed from the early forms devised by Galileo and the Dutch opticians, had been known but half a century, and that the first important step in its improvement was at this very time about to be taken by Newton himself. Although it was a period of great scientific activity, embracing such names as Gregory, Hooke, Sir Christopher Wren, and Boyle in England, and La Place, Leibnitz, Hugghens, and Bernouilli on the continent, the system of natural philosophy still in vogue was the Cartesian, the absurdities of which, day by day more manifest, were nevertheless inadequate to dethrone it until these and other remarkable advances had taken root, and the Newtonian philosophy, nearly half a century later, had finally become established in the universities. It was the beginning of a struggle against the extreme dogmatism of the period — a struggle which was to end in the introduction of experimental demonstrations, and so in the planting of the germ from which have sprung the great laboratory systems of the present time.

Starting from the complex character of sunlight as a foundation, the science of color in the hands of Newton and his followers made rapid progress, until the various ways in which, in nature, certain components of sunlight become isolated and appear as color, have become well known. We are thus able to divide all colors into two great classes — objective and subjective, and have learned that objective colors are formed either by the absorption of other rays or by interference; while subjective colors are due to physiological processes by means of which the eye is rendered more sensitive to certain colors than to the other components of the light which reaches the retina.

The blue of the sky is due, then, to absorption or to interference, or it is of subjective character. Newton[1] himself thought it due to interference, but it is cus-

[1] Newton; Optice, London, 1706.

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tomary in our own times to ascribe the existence of the azure to atmospheric absorption.

In order to show the distinction between these blues, permit me to repeat a few well-known experiments. We have, in the rays of light issuing from the lantern, all those components which go to make up sunlight, only in slightly different proportions. If we place in the path of the ray a piece of cobalt glass, or this solution of sulphate of copper, nearly all the colors are absorbed, and their energy goes to heat the interposed medium. A few rays, however, are transmitted and fall upon the screen, of which the blue predominate to so great an extent as to determine the character of the resulting color, and to give us good examples of what are known as absorption blues.

There is, however, another way in which these other colors may be disposed of. Whenever white light is reflected from the surfaces of very minute transparent bodies, or of extremely thin films, the light-waves thus reflected interfere with each other, by which process some colors are destroyed, and others increased in intensity. One of the most convenient ways of showing this phenomenon, to which we owe many of the most striking and beautiful of nature's tints, the magical coloring of the peacock and the humming-bird, the varied hues of tropical beetles and butterflies, is by means of the familiar soap-bubble film. Here we have a substance which, without any intricate or difficult manipulation on our part, grows rapidly thinner and thinner, until it begins to show a play of interference colors of surpassing brilliancy. When we reflect the ray of the lantern from such a film and focus its image upon the screen, we have before us a shifting field of these interference colors. As the increasing tenuity of the film destroys each component of the ray in turn, each color of the spectrum in turn predominates, and we obtain at certain stages of the experiment interference blues of such intensity and delicacy that they may, with much more propriety, be compared with the blue of the sky than any absorption blue which can be produced by artificial means. What wonder that Newton, who made the first thorough investigation of this class of colors, and that many observers after him, should have ascribed the sky-blue to this source!

Experimental treatment of the subjective blues before a large audience is a much more difficult matter, and I shall content myself with a single very simple experiment, in illustration of one of the methods by which this class of colors may be produced. The distinguishing feature of the subjective blues is, that they do not depend upon the destruction of any portion of the spectrum by absorption or interference, but arise from temporary peculiarities of the retina of the eye, by which it becomes incapable, in one way or another, of receiving all the impressions which, in the normal retina, would be sent to the brain, there to be united in the complex sensation which we call white. The study of the color-sense shows that color-sensation, which appears at first sight exceedingly complicated, may be very simply explained by supposing the existence of three classes of nerve-fibers in the eye, each capable, whatever may be the character of the stimulus acting upon it, of transmitting a single message. One set conveys the impression which we call red, another green, and the third violet—the three primary color sensations by the union of which, in varying proportions, we are enabled to perceive the many thousands of hues which the outside world presents to vision. Now, the production of a subjective color depends upon this, that when white light enters the eye one or more of these nerves is unable to properly perform its function, so that the brain, instead of receiving the sensations due to white light, gets an incomplete impression, in which some necessary component is enfeebled or missing. Whenever this happens the observer perceives color, the nature of which depends upon which nerve it is that fails to act. The sole distinction, then, between objective and subjective colors lies in the man-

ner in which the missing components are destroyed: when by absorption or interference before the ray enters the eye, the color is said to be objective; when within the eye, by the failure of certain portions of the optic nerve to perform their function, we term the thereby-modified sensation conveyed to the brain a subjective color. The influence of different portions of the spectrum upon these three sets of nerves, has been studied by Helmholtz,[1] Maxwell,[2] and others, and the result of their very laborious investigation is shown in the accompanying diagram. (Fig. 1.)

Each wave-length of the visible spectrum affects all three nerves, although in very different degrees. And so all colors, even to the tints of the "pure" spectrum, are really trifold, consisting of a mixture of these three primary color sensations. When all three nerves are equally affected, the result is white; and the color differs from white whenever the impression upon one set of nerves is enfeebled or unduly strengthened.

These color nerves in the eye become temporarily weakened whenever they are strongly stimulated, and their temporary enfeeblement is the chief cause of subjective color. Contrast effects are among the most familiar examples of subjective color sensation. They are always present, serving to heighten or to diminish brilliancy of hue, according to the arrangement of the colors upon which we gaze. If you will stare intently for a moment upon that patch of yellow light upon the screen, you will see that when I withdraw the bit of glass which caused it, from the field of the lantern, that portion of the screen, really a pure white, becomes suffused with an indescribably delicate shade of blue. The blue is produced by white light from the screen entering your eyes, the red and green-transmitting nerves of which have been somewhat fatigued by exposure to yellow, which is principally made up of these two compounds. The nerves which transmit violet have been resting, meantime, because those portions of the lantern's rays which would have affected them were absorbed by the yellow glass; and so the message carried to your brain, instead of consisting equally of the impressions of red, green and violet, now consists chiefly of the last. The violet-carrying nerves are unusually active after their short period of repose, while those burdened with the red and green are fatigued by exposure, and scarcely act at all. The resulting sensation is of an excess of violet light, mixed with green and red to just the extent necessary to produce the subtle and very delightful blue you have just seen. The effect vanishes as the tired nerves regain their normal sensitiveness, and the white screen regains its ordinary appearance.

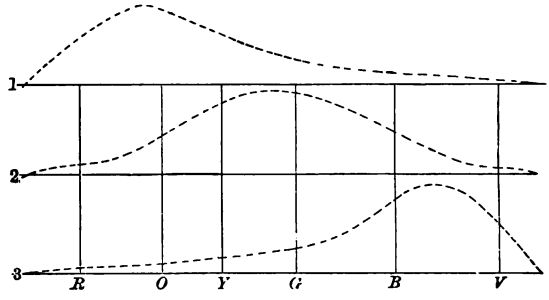

FIG 1.

After this brief discussion of the causes to which color is due, we are ready to consider some of the theories of the color of the sky which have prevailed in more recent times.

Newton's hypothesis, that sky-blue is produced by inference, has been abandoned long since, on account of difficulties which we cannot touch upon here, and has been supplanted by the simpler theory that the color is due to atmospheric absorption

[1] Helmholtz: Handbuch der physiologischen Optik, p. 317.
[2] Maxwell: Philosophical Transactions, vol. CL, p. 78.

of the less refrangible rays. Many attempts have been made to fix upon the precise medium to which this absorption may be due.

The fact that water is always present in our atmosphere, in a state of fine subdivision, has naturally led philosophers to look to it as the absorbing medium. The establishment of this theory depends, however, upon the ability to show that sunlight, when viewed through a sufficiently thick layer of water, appears blue; but the very numerous experiments upon this subject have given a great variety of results. Many waters, notably those of Lake Geneva and of the deep sea, have this blue color to a marked degree. Others, when viewed by transmitted light, appear green, yellowish, and even brown. The presence of impurities, even in almost inconceivably minute quantities, has been found to produce striking changes of color. Thus water newly distilled is blue, but, upon standing even for a few hours in perfectly clean vessels, it becomes green, yellow, and even brown; changes which have been traced to the presence in increasing numbers of microscopic organisms, so minute and so transparent as to test the microscope in the severest manner. Loret, who has studied this subject exhaustively, in the hope of solving the problem of the color of the water of Lake Geneva, finds that otherwise pure water containing silica produces absorption blues, to which he ascribes the blue color of newly-distilled water.[1] The

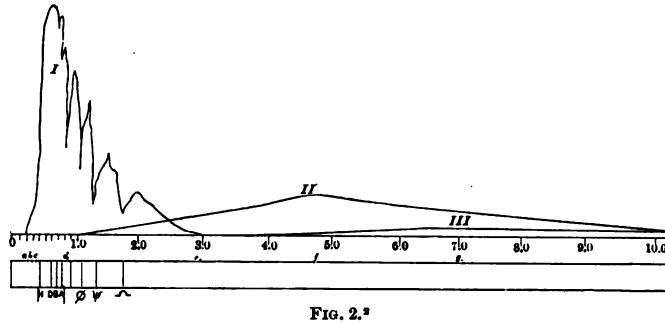

FIG. 2.[2]

addition of other impurities, especially iron, such as give a yellow instead of a white residue upon evaporation, convert this blue into green, and ultimately into brown. The presence of minute quantities of silica in the water of the atmosphere has led him to ascribe the color of the sky to the presence of this element in the water floating in the air.

The gaseous components of our atmosphere have also been looked to as the absorbing media to which we owe the color of the sky, and one of these — ozone — having been recently found to possess an absorption spectrum rich in violet rays, ozone has been declared the substance to which the azure is due.

The long prevalent opinion that the atmosphere, taken as a whole, transmits the violet rays more readily than those of longer wave-length, has been controverted by the investigations of our countryman, Professor Langley, who brought to bear upon this very difficult problem a new instrument of his own invention, an apparatus of hitherto undreamed of delicacy. Langley's instrument — the bolometer — makes it possible to measure radiant energy accurately by electrical means, even when the rays are so feeble as to be quite out of the reach of the most sensitive of the former apparatus devised for this purpose. Scarcely exceeded in delicacy by the eye itself, the bolometer is not confined like the eye to impressions from the very limited

[1] See E. Ray Lancaster, Nature. Vol. II, p. 235.

[2] From Langley's Monograph; Researches on Solar Heat and its Absorption by the Earth's Atmosphere: Professional Papers of the Signal Service, No. 15.

series of rays which comprise the visible spectrum. It is affected by all wave-lengths in proportion to their intensity, and in the skillful hands of its inventor it has been the means of bringing to our knowledge a vast and important series of heat-waves hitherto undetected. By its use it is now possible to analyze and study the radiation from bodies of low temperature — even below the freezing point of water — with almost the same certainty and precision as that from substances in a high state of incandescence. The diagram now on the screen (Fig. 2) shows the results of some measurements by Professor Langley of the radiation from substances at 100° C. and —2° C. The curves show the energy of each wave-length emitted, and present to our view spectral regions far beyond the infra-red of the solar spectrum. The very limited region lying between *A* and *H*, comprises those rays which are capable of affecting the human retina. The most refined methods previously known to science had extended our acquaintance with the longer wave-lengths only to the point marked ⌒. Beyond lay the still longer waves due to radiation at low temperatures, the wave-lengths and intensities of which are indicated in these curves.

Armed with this wonderful instrument, and possessed of skill and perseverance given to few, Professor Langley made exhaustive studies of the quality of the sun's rays after they had been sifted by passing through the miles of atmosphere above his observatory at Alleghany. He then took his instruments and a corps of trained assistants across the continent to a remote point in the American desert which was known to possess an atmosphere of unrivaled purity, established a temporary station at the base of Mt. Whitney, and repeated his measurements there.

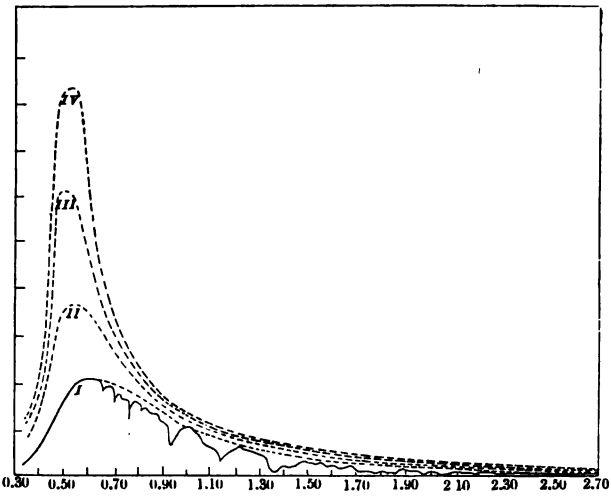

FIG. 3.[1]

The party then ascended the almost inaccessible peak to an elevation of 14,000 feet, and with nearly half the earth's atmosphere below them, succeeded in making a determination of the quality of sunlight at this high station. Of the dangers and difficulties of bringing across the desert and up the mountain all the delicate apparatus necessary to such a research, only those who accompanied the expedition can form any adequate conception. The published accounts furnish one of the most romantic passages in the history of science.

The energy curves of sunlight obtained at these three stations (Fig. 3) are of the highest scientific interest. They show beyond dispute that the earth's atmosphere absorbs much more of the violet and other more refrangible rays than of the red wave-lengths; so that could we ascend entirely beyond the atmosphere, sun and stars would appear much bluer than they do at the surface of the earth. It seems

[1] From Langley's monograph; l. c.

quite certain, in the light of these researches, that we look out into the heavens through a reddish opalescent haze, which greatly modifies the quality of the sun's rays to us, producing an effect not unlike that of Indian summer.

Professor Langley's study of the absorption spectrum of the earth's atmosphere has simplified the problem of the color of the sky by excluding a number of hypotheses which are incompatible with his results. It necessitates our looking for the blueness of the sky in some action of the atmosphere other than absorption, since his experiments show conclusively that sunlight becomes less and less blue by transmission through the air. Much light has been thrown upon the process by which the azure may be formed, by Tyndall's famous experiment, known as the "*artificial sky.*" While studying the decomposition of vapors by sunlight, Tyndall had occasion to send a powerful ray of white light through a tube containing a certain organic vapor (the nitrite of amyl). This vapor was broken up by the light, and some of its constituents were precipitated in the form of a fine cloud, which grew denser and denser as the experiment proceeded. This cloud when forming, presented a beautiful blue appearance strikingly suggestive of the open sky, which gave way as the precipitate increased in intensity, to a milky whiteness.[1] This incipient cloud Tyndall called his artificial sky, and the belief that it is very closely allied in character to the true sky, although the substances from which the color arises are of course not the same, is very much strengthened by the evidence of the polariscope.

One of the most puzzling features of the light reflected from the sky is its polarization, which differs from that of the light reflected by water, or indeed by any solid or liquid substance. Now the angle of maximum polarization of the artificial sky was found to be the same as that of the real sky, and the same thing has since been shown to be characteristic of the rays reflected by many other substances when in a state of exceedingly fine subdivision.[2]

A similar blue has also been produced by Lord Rayleigh, by the precipitation of sulphur from solutions of the hyposulphite of soda by means of hydrochloric acid. This experiment is so simple, that I will try to reproduce it for your benefit.

Here, as in Tyndall's experiment, the blue is most marked at the moment when the cloud is beginning to form; and it is speedily supplanted by the milky appearance characteristic of opalescent solutions. It is the peculiarity of all the solutions capable of giving the blue cloud to transmit red light and absorb the shorter wavelengths. When we pass the rays of the lantern through a cell containing the milky liquid obtained in this experiment, the white light upon the screen becomes ruddy, and the effect upon the rays passing through the solution is similar to that which the earth's atmosphere exerts upon the rays of the sun in their journey to the surface of our planet. We live, in a word, at the bottom of a vast sea of opalescent material, which transmits the sunbeams to us with their blue and violet components enormously reduced, and which reflects, from the multitudes of exceedingly small particles suspended in it, light which produces upon the retina the same effect as the light reflected by the "artificial sky" of Tyndall, or of Rayleigh. I shall show you presently that true sky light is almost identical in composition with the light from these artificial skies.

The experimental evidence concerning the real nature of these colors is exceedingly meager. A variety of observations of my own led me some years ago to call in question the generally accepted view that the blue of the sky is of objective character like that transmitted by cobalt glass or produced by reflexion from such pig-

[1] Tyndall; Fragments of Science, p. 93; also, Contributions to the Domain of Molecular Physics, p. 425.

[2] See Burch; "Some Experiments on Flame;" Nature, vol. 31, p. 272.

ments as indigo and ultramarine. That the world should be flooded with light of the sky's deepest blue, and that nevertheless we should be spared even a trace of the very peculiar effects produced when we substitute blue glass in the windows of a room for that of the usual neutral tint, or color the walls with ultramarine, is, to say the least, remarkable. One might suppose that whenever light from the sky, undiluted by the direct rays of the sun, became the chief source of illumination, its influence would be obvious to the most careless observer; modifying the colors of every object, and producing a thousand marked changes in the aspects of nature. The reverse is true, and even the multitude of less obvious phenomena with which only the artist and the special student of color might expect to meet with in consequence of the blueness of light from the sky are lacking. In clear weather the daylight which penetrates every nook and cranny of the inhabited world is sky light, save where the direct rays of the sun may chance to fall, and it is found to vary from direct sunlight in no respect, excepting in intensity.

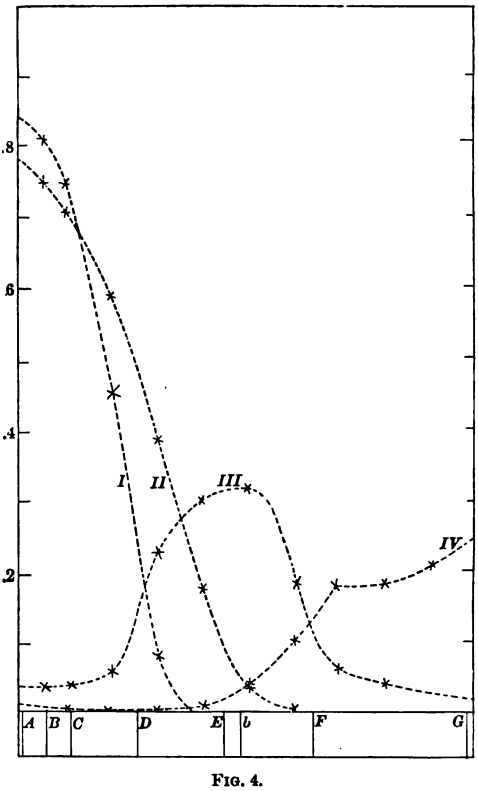

FIG. 4.

We are not in the habit of assigning to it even that degree of blueness which in the popular mind is associated with moonlight. Even those who use the spectroscope have long since noticed the absence of any marked difference between light from the sun, that reflected from white clouds, and that which reaches us from the open sky.[1]

In the spectrophotometer we have a modification of the spectroscope by means of which it is possible to compare the intensity of spectra, wave-length for wave-length. An analysis of colors with this instrument shows all of them, excepting the tints of the pure spectrum, to be modifications of white in which one portion or another has been destroyed by absorption within the substance to which the color belongs. Upon the screen you see the spectrophotometric curves characteristic of four well-known pigments, viz.: red lead, chrome yellow, chrome green, and artificial ultramarine, (Fig. 4.)[2] Such curves, indicating as they do the relative intensities

[1] In exception to this statement stand, however, observations by Rayleigh, (Philosophical Magazine, 1871,) who found in the spectrum of the open sky a *slight* excess of the more refrangible wave-lengths, and more recently by H. C. Vogel, (Photographische Mittheilungen 20, 1883, p. 74,) who found evidence in photographed spectra of the sun and of the sky, of a preponderance of ultra violet rays in the latter.

[2] Taken from the author's paper entitled, "A Spectrophotometric Study of Pigments," Am. Journal of Science, vol. 28, 1884.

of all the various rays which enter into the composition of the colors in question, give no definite knowledge of the nature of the light to which pigments owe their characteristic hues.

Soon after the completion of the measurements the results of which are indicated in these four curves, it occurred to me that an important step toward the solution of the problem of the color of the sky might be made by directing the spectrophotometer to the sky itself, and comparing its spectrum throughout with that of some neutral white substance capable of reflecting all colors equally well. I attempted such an analysis in the spring of 1885. It is not my purpose to enter here into the details of that research. Some of the difficulties encountered in the selection of a white substance suitable for the comparison will be described in my paper entitled "Black and White." [See pp. 37–44 of these Transactions.] The pigment finally adopted was the carbonate of magnesium. This analysis brought out the remarkable fact that the light which the sky reflects to us, although differing from direct sunlight to a measurable extent, yet corresponds with the latter quite as closely as does that reflected by any white pigment which I have studied. Its deviation from true whiteness, which varies from day to day and from hour to hour, does not always consist as the appearance of the sky would lead us to suppose, in any marked excess of blue rays. Indeed, the first sky which I subjected to measurement was found to be deficient in the very rays upon which the existence of an objective blue depends. The curves now shown upon the screen are those pertaining to the spectrum of the sky on April 28, May 1, and May 4, 1885. Light reflected from a perfectly white body would be represented by the horizontal line. (Fig. 5.) Deviations from that line denote excess or deficiency of the rays belonging to the corresponding regions of the spectrum, as indicated by the Fraunhofer lines at the bottom of the diagram.

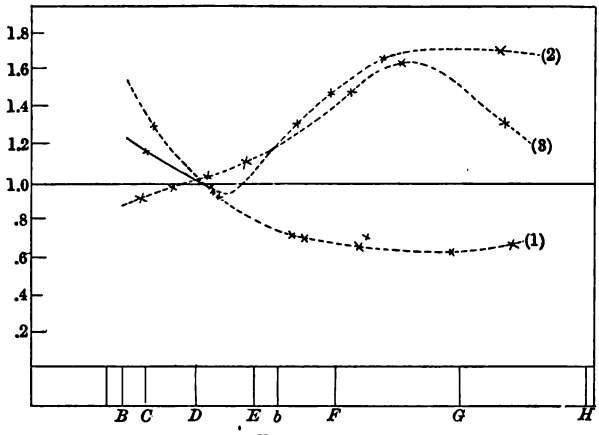

FIG. 5.

On April 28 (see Curve 1, Fig. 5), the sky was of more than average blueness, so far as the eye could judge, yet its spectrum was found to possess more red and less blue and violet than belong to a true white, being in this respect almost identical with the magnesium carbonate with which it was compared. On the first of May (see Curve 2, Fig. 5), a sky, to the unaided eye very like the first, showed a decided excess of blue; while on the 4th of May (see Curve 3, Fig. 5), the predominating color, as shown by the spectrophotometer, was greenish-blue, the violet rays being comparatively feeble.

In order to understand the extent to which these variations from true whiteness were capable of influencing the hue of the sky as observed by the unaided eye, let us compare these curves with those obtained by the same method and with the same instrument from various substances, which had been selected because of their unusual whiteness. Specimens of magnesium carbonate, of plaster of Paris and of

white paper, which had been treated in the process of manufacture with an almost infinitesimal amount of some blue pigment for the purpose of counteracting the slightly yellowish cast common to these substances in their natural state, and to give them brilliancy, were subjected to analysis with the spectrophotometer. It will be seen from the curves obtained from their spectra (Fig. 6), that they all vary quite as much from true whiteness as does the sky, and yet they had been selected as uncommonly pure specimens of white pigments in my search for a suitable standard of comparison; and the existence of the blue adulterant had been entirely unsuspected until revealed by measurements with the spectrophotometer.

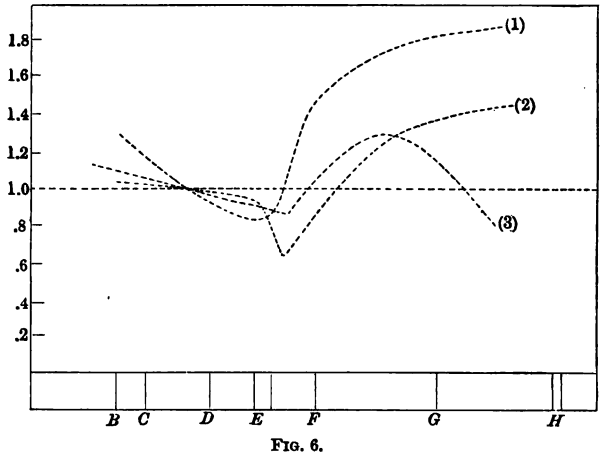

FIG. 6.

. The "artificial sky" of Lord Rayleigh and the beautiful blue blowpipe films of antimony oxide, so familiar to the chemists when studied with the spectrophotometer, exhibited the same peculiarity as the azure of the true sky, excepting that these opalescent blues possessed very faint spectra which differed less from that of an absolutely white substance than any of the objects which I had analyzed.

Was Leonardo da Vinci right, then, in deeming the azure an optical illusion, or as we should now call it, a "subjective blue"? I know of no other interpretation of the results of the spectrophotometric analyses to which I have just alluded. The subject is fraught with great experimental difficulties, and we have still almost everything to learn concerning the color of the sky.

Should these measurements meet with final corroboration, and the subjective character of the azure be thereby established, two important elements in the production of the blueness of the sky will be found. In the first place, a true white is much bluer than the standards of whiteness which we have been forced to adopt in the absence of anything better; and in the second place, the well-known sensitiveness of the eye to the violet components of all colors of low intensity increases this blue of contrast to an extent which we little realize.[1] That these two factors are always at work intensifying the azure, is already beyond question. To assert that they are the only important factors, and that the excess of violet rays in the spectrum of light from the sky plays no essential part in the production of its color, upon evidence derived from a limited set of experiments like my own, would be premature. We must await more exhaustive researches at the hands of those competent to assail successfully this great problem, before we can hope for a final decision between the various theories which I have attempted to touch upon this evening.

UNIVERSITY OF KANSAS, November, 1886.

[1] See Albert; Annalen der Physik und Chemie, N. F. 16, p. 129.

TABLE OF THE FAMILIES OF DIPTERA.

BY PROF. S. W. WILLISTON.

The following dichotomous table for the determination of the families of diptera has been prepared in response to the requests of a number of correspondents who desired some ready means of separating and classifying their material. It is intended for the assistance of the general entomologist or beginner in dipterology more especially, and is in no wise a classificatory exposition of the subject, except in so far as it separates families.

The beginner will be much aided by having at his command a small collection of determined specimens, together with a considerable material for comparison. Difficulties to the inexperienced will often disappear with positive evidence before him, where negative characters may be puzzling. In lieu of such material, or even with it, the few following directions will be of assistance.

Let him select for comparison a common large horsefly (*Tabanidæ*) and a common house or bluebottle-fly (*Muscidæ*). By comparing the tip of the tarsi (feet) in the two, he will immediately observe what is meant by the expression, "Empodia developed pulvilliform." The middle membraneous appendage on the under side of the claws in the horsefly is the pulvilliform empodium, while in the housefly the two outer ones, the pulvilli, alone are present. The tarsus, composed of five joints, the tibia, the femur, and the coxa, attaching the leg to the thorax, will be readily understood.

The antennæ of the housefly will show what is meant by three simple joints, the third of which bears the dorsal arista. The third joint in the horsefly, on the other hand, will be seen to be "complex," that is, composed of a number of closely united segments; it is also without style or bristle. The three, small, simple eyes (*ocelli*) will be seen at the vertex in the housefly. The tegulæ are flattened membraneous scales, one overlapping the other, just back of the root of the wings, and covered over by them; they are well developed in both flies.

To understand the neuration, observe in the horsefly, near the middle of the wing directed transversely, a large, oblong, five or six-sided cell, surrounded on all sides by other cells. This is the discal cell, and is present in the majority of flies. In nearly all cases, somewhere on the vein (fourth longitudinal) that bounds this cell in front, will be seen a short connecting vein, directed anteriorly; this is the anterior or small cross-vein, and affords, in most cases, a key to the neuration, no matter how intricate. It always connects the fourth longitudinal vein behind with the third longitudinal in front; the cell behind it is the discal, in front the submarginal, on the outer side the first posterior, on the inner side the first basal. Lying parallel with the first basal cell, and just behind it, is the second basal cell; just behind the second basal cell is the third basal or anal cell. In the horsefly, the anal cell is seen to run back obliquely to near the posterior margin of the wing, where it terminates acutely, that is, the anal cell is said to be closed near the border of the wing; should the two veins that close it run separately into the wing's margin, then the cell is open. Now, counting outwardly along the posterior border to the third longitudinal vein (posterior branch), there will be seen five posterior cells, all open (except in a few species of our *Tabanidæ* the first posterior cell is closed), with their bases bordering on the discal and first and second basal cells. By following the third longitudinal vein outwardly from the anterior cross-vein, it is seen to give off an anterior branch, which runs to terminate in the front margin or costa of the wing; the third longitudinal vein is here furcate, and two submarginal cells are present. Compare now these same structures in the housefly, and the discal cell is found much

more elongated, the basal and anal cells small, the third longitudinal vein simple, not furcated, and only one submarginal and three posterior cells are present. Do not confound the obliquely placed vein that nearly closes the first posterior cell with the furcation of the third vein. The housefly will also show clearly the six longitudinal veins, the last of which runs obliquely backward from the anal cell toward the margin, the fifth bordering the discal cell behind, the first and second running into the costa. The first vein that terminates in the costa (before the middle of the wing) is the auxiliary. The vein that closes the discal cell outwardly is the posterior or great cross-vein; the one that closes the anal cell outwardly, the posterior basal cross-vein.

The above will indicate the leading principles of the neuration and structure peculiar to flies. For further information, the reader is referred to the system of terminology given by Loew in the first volume of the Monographs of North American Diptera, a system which, upon the whole, I believe to be superior to any other now in use.

The numerous sub-families of the *Muscidæ acalyptratæ* are omitted; I am not able to include them satisfactorily.

TABLE FOR THE DETERMINATION OF THE FAMILIES OF DIPTERA.

1. Flies of a leathery or horny structure, living parasitically in the adult state upon warm-blooded vertebrates or bees; head small, either closely united to the emarginate anterior part of the thorax, or folding back into a groove upon the dorsum; mouth-parts incomplete, the palpi wanting; legs separated by the broad sternum; abdomen indistinctly segmentated; claws well developed.. 49

   Flies of softer structure, never living parasitically in the adult state upon warm-blooded vertebrates; head separated from thorax by a free neck..... 2

2. Antennæ many-jointed, often longer than the thorax, the two basal joints, only, differentiated, the remaining joints usually distinct; palpi composed of from three to five joints, usually elongate; anal cell never closed or narrowed at the margin*. (*Nematocera.*)..... 3

   Antennæ rarely as long as the thorax, composed primarily of three joints, the third of which may be simple or complex, (that is, composed of more or less distinct annuli or segments,) with or without a terminal or dorsal arista or style; anal cell closed before the border, or distinctly narrowed in the border, or, if of other structure, the antennæ composed of three simple joints; palpi rarely much elongate, composed of from one to three joints..... 12

3. Dorsum of thorax with a distinct V-shaped suture†; wings (wanting in *Chionea*) many-veined, often with a complete discal cell; ocelli wanting (present in *Trichocera*); often large flies.....TIPULIDÆ

   Dorsum of thorax without a V-shaped suture, or rarely with any transverse suture (*Blepharoceridæ*)..... 4

4. A complete discal cell present; ocelli present; empodia developed pulvilliform, pulvilli rudimentary.....RHYPHIDÆ

   No discal cell..... 5

**Piscia*, and perhaps some others, may be exceptions.

†*Bittacomorpha*, *Ptychoptera*, and *Idioplasta* will alone cause doubt here. They have the suture incompletely V-shaped and sinuous. The last will be distinguished from *Rhyphidæ* chiefly by the absence of ocelli; the two former will be separated from the *Culicidæ* by the absence of hair on the veins, their larger size, and in *Bittacomorpha* by the peculiar clubbed tibiæ.

5. Wings with only a few longitudinal veins, and no cross-veins; coxæ not elongate, tibiæ without terminal spurs, legs not thickened; ocelli present or absent; small or minute, delicate, mostly gall-producing flies..... CECIDOMYIDÆ
Not such flies, wings usually many-veined..... 6

6. Ocelli present..... 7
Ocelli wanting (compare *Mycetophilidæ*)..... 9

7. Wings broad, bare, characteristically marked by numerous folds between the veins, giving a netted, spiderweb-like appearance..... BLEPHAROCERIDÆ
Wings not so marked; no entire transverse suture..... 8

8. Coxæ much elongated (moderately so in *Sciarinæ*); antennæ often elongate, the joints constricted; three or two ocelli (in the latter case situated near the eyes, and often hardly perceptible); all the tibiæ with spurs..... MYCETOPHILIDÆ
Coxæ short, the thorax rounded, not humped, above; antennæ shorter than the thorax, thickened, the joints closely united without marked constrictions; legs strong, the front femora often thickened; empodia pulvilliform, the pulvilli sometimes absent; eyes of male large..... BIBIONIDÆ

9. The costal or marginal vein does not extend beyond tip of the wing..... 10
The marginal vein encompasses the entire wing..... 11

10. Antennæ slender, the joints more or less constricted, and often bushy plumose; legs slender, hind tibiæ and metatarsi never dilated; body and abdomen slender; wings narrow..... CHIRONOMIDÆ
Antennæ shorter than the thorax, the joints broadly and closely united, without marked constrictions, and never hairy or pilose; legs strong, hind pair more or less dilated; body thick-set, abdomen ovate; wings broad, bare, the anterior veins stouter, the posterior ones weak. Black flies, buffalo gnats... SIMULIDÆ

11. Wings distally, with ten longitudinal veins, without cross-veins, broad, pointed, veins strongly hairy; tibiæ without terminal spurs; small, lepidoptera-like flies, the wings when at rest, folded roof-shaped..... PSYCHODIDÆ
Wings with small cross-veins near the middle, not broad and pointed, the veins hairy and conspicuously fringed along the hind margin; wings when at rest not roof-shaped. Mosquitoes..... CULICIDÆ

12. Third joint of the antennæ complex; basal cells of wing long..... 13
Antennæ composed of three simple joints, the third not annulated or segmentated, with or without a dorsal arista, or terminal style or arista..... 19

13. Empodia undeveloped or bristle-like; antennæ elongate, composed of four or five joints, without differentiated style or arista; vertex and front hollowed out transversely between the eyes; eyes of male never contiguous..... 25
Empodia developed pulvilliform; third antennal joint more or less distinctly segmentated or annulated..... 14

14. Tegulæ rather large; third longitudinal vein furcate; five posterior cells always present; the costal vein encompasses the whole margin of the wing; proboscis of the female adapted for piercing; third joint of antennæ with from three to eight annuli, never with style or bristle. Horseflies..... TABANIDÆ
Tegulæ small or rudimentary; mostly flower-flies..... 15

15. Tibiæ wholly without terminal spurs..... 16
The middle tibiæ at least, with distinct spurs; the costal vein encompasses the entire wing; third longitudinal vein always furcate, and five posterior cells always present..... 17

16. Longitudinal veins of the wings usually crowded anteriorly, those posteriorly often weak; the costal vein does not reach beyond the tip of the wing; antennæ long or short, with or without a terminal or dorsal arista or style. STRATIOMYIDÆ

Longitudinal veins not crowded anteriorly; the marginal vein encompasses the entire wing; third longitudinal vein always furcate, and five posterior cells always present; third joint of antennæ never with style or bristle..... 17

17. All the tibiæ with spurs; third joint of antennæ sometimes divided into separate joints..... XYLOPHAGIDÆ

Front tibiæ without spurs..... 18

18. Fourth posterior cell of wings closed (*Subula*)..... STRATIOMYIDÆ, *pt.*

Fourth posterior cell open (*Arthrocerinæ*)..... LEPTIDÆ, *pt.*

19. Antennæ apparently single-jointed, with a long bristle; wings with several stout veins anteriorly, and other weaker ones running across the surface unconnected by cross-veins; femora flattened; the hind legs long; antennæ situated near the mouth; small, quick-running, hunchback-like flies..... PHORIDÆ

Not such flies..... 20

20. Empodia developed pulvilliform, that is, three nearly equal, membraneous appendages on the under side of the claws..... 21

Empodia wanting, rudimentary or linear, not developed like the pulvilli.... 23

21. Tegulæ very large, inflated; thorax and abdomen inflated; head small, eyes very large; neuration varied..... CYRTIDÆ

Tegulæ of moderate size or rudimentary..... 22

22. Middle tibiæ, at least, with spurs, no bristles on femora or tibiæ; third longitudinal vein furcate; five posterior cells present (four in *Agnotomyia*); anterior cross-vein always distinct; third joint of the antennæ with a bristle or slender style, usually terminal..... LEPTIDÆ

Not such flies..... 23

23. Third longitudinal vein of the wing simple, not furcate..... 32

Third longitudinal vein furcate, two or more submarginal cells present..... 24

24. Arista or style of antennæ, when present, always terminal..... 25

Arista dorsal, always present..... 37

25. Vertex and front distinctly hollowed out transversely between the eyes; eyes of male never contiguous; basal cells large; mostly large flies..... 26

Front and vertex plane or convex; eyes of male often contiguous..... 27

26. Proboscis without fleshy labellæ at the tip, the under part forming a horny sheath; the posterior branch of the third vein terminates behind the tip of the wing; five posterior cells always present; predaceous flies..... ASILIDÆ

Proboscis with fleshy labellæ at the tip; neuration complicated, the third vein, at least, curves forward to terminate before the tip of the wing; antennæ with a terminal flattened lamella..... MIDAIDÆ

27. Five posterior cells in the wing; basal cells large..... 30

Never more than four posterior cells in the wing..... 28

28. Third antennal joint without bristle or style; three posterior cells; first posterior cell narrowed or closed, the fourth longitudinal vein terminating at or before the tip of the wing..... SCENOPINIDÆ

Third antennal joint rarely without terminal style; four or three posterior cells; the fourth vein terminates beyond the tip of the wing 29

29. Anal cell narrowly open, or closed near the border ..... BOMBYLIDÆ
Anal cell closed, remote from the border ..... EMPIDÆ

30. Neuration intricate, the small cross-vein wanting or rudimentary, owing to the coalescence of the third and fourth veins for a longer or shorter distance; tibiæ without terminal spurs; empodia and pulvilli membraneous, but frequently minute ..... NEMISTRINIDÆ
Neuration not intricate; the anterior cross-vein always distinct; labellæ of proboscis fleshy 31

31. The posterior branch of the third vein terminates before the tip of the wing; male sexual organs prominent ..... APIOCERIDÆ
The posterior branch of the third vein terminates behind the tip of the wing; male sexual organs small ..... THEREVIDÆ

32. Antennæ with a dorsal arista 38
Antennæ with a terminal arista or style 33

33. Wings pointed, no cross-veins in the middle, the fourth longitudinal furcate and united with the fifth; small species ..... LONCHOPTERIDÆ
Wings rounded at the tip, not lancet-like 34

34. Second basal cell confluent with the discal cell, not separated by a small vein; the auxiliary vein does not terminate in the costa; small, mostly brilliant-colored, predaceous flies ..... DOLICHOPODIDÆ
Second basal cell separated from discal cell by a small vein 35

35. Antennæ with a terminal style 36
Antennæ with a terminal bristle 37

36. First posterior closed (*Conopidæ*, pt., *Syrphidæ*, pt.) 41
First posterior cell open ..... EMPIDÆ

37. Head comparatively small; the proboscis usually more or less elongated; alulæ of wing usually rudimentary ..... EMPIDÆ
Head as broad as the thorax; proboscis fleshy; alulæ distinct ..... PLATYPEZIDÆ

38. Proboscis rudimentary, palpi wanting: first posterior cell usually narrowed; tegulæ usually large. Botflies ..... ŒSTRIDÆ
Proboscis not rudimentary; palpi present 39

39. Second basal cell confluent with the discal cell; not separated by a small vein; small, mostly brilliant-colored, predaceous flies; face never broad and convex. DOLICHOPODIDÆ
Second basal cell separated from the discal cell by a small cross-vein (or, if not, not brilliant-colored, predaceous flies, and the face always broad and arched, *Ephydrinæ*) 40

40. Posterior basal cells of wing elongate; the anal cell closed toward the margin; first posterior cell closed or much narrowed (except sometimes in *Pipunculidæ*) 41
Posterior basal cells of wings small; the anal cell always closed remote from the margin 43

41. Face with sub-antennal vertical grooves or depression. (*Conopidæ*, pt.) 43
Face convex transversely, or with a median ridge; never with a sub-antennal depression 42

42. Between the third and fourth longitudinal veins, and sub-parallel with them, crossing the anterior cross-vein, a spurious longitudinal vein, or, when rarely not present, the first posterior cell closed a considerable distance from the border; eyes never extraordinarily large; abdomen never with bristle. SYRPHIDÆ

Spurious vein never present; first posterior cell never closed before the margin; eyes very large, including the largest part of the head; small species. PIPUNCULIDÆ

43. Proboscis horny, elongate, often folding back near the middle; abdomen never with bristles; tibiæ without terminal spurs (or, if with them, the face with a median ridge, and the proboscis folding); first posterior cell closed or narrowed..... CONOPIDÆ

Proboscis fleshy and not elongate, (or if elongate and slender, with or without a median hinge, the abdomen with distinct bristles, or the antennæ plumose)..44

44. Tegulæ large; face with sub-antennal vertical grooves or depression. (*Muscidæ calyptratæ*) 45

Tegulæ small..... MUSCIDÆ ACALYPTRATÆ

45. First posterior cell widely open, not narrowed in the margin..... ANTHYOMYIDÆ

First posterior cell closed, or more or less narrowed..... 46

46. Antennal arista wholly bare..... TACHINIDÆ

Antennal arista distinctly pubescent or plumose..... 47

47. Arista bare on the distal part; dorsum of abdomen rarely bristly before the distal part..... SARCOPHAGIDÆ.

Arista plumose or pubescent to the tip..... 48

48. Dorsum of abdomen bristly; legs usually elongate..... DEXIDÆ

Abdominal segments without bristles, except sometimes somewhat near the tip. MUSCIDÆ

49. Wingless flies, parasitic upon bats; head not flattened, folding back upon the dorsum of the thorax; first joint of tarsi not abbreviated..... NYCTERIBIDÆ

Winged or wingless flies, parasitic upon birds, quadrupeds, or bees; head flattened, sunk into a shallow emargination of the thorax; first joint of the four anterior, or all, tarsi abbreviated..... HIPPOBOSCIDÆ

For the determination of the genera and species, a large number of papers must be consulted, a list of which would be out of place here, and which, up to 1878, will be found in Osten Sacken's Catalogue (Smithsonian, 1878), a work whose necessity will be first to the student. Papers published since that time on North American Diptera have been by the following authors: C. R. v. Osten Sacken, F. M. v. d. Wulp, F. Brauer, V. v. Roeder, J. Mik, J. F. M. Bigot, F. A. F. Karsch, E. Burgess, D. W. Coquillett, and the writer. The following list only, containing such papers as present tables or descriptions of the North America genera, in the families named, may be given:

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ŒSTRIDÆ. Brauer, Monographie der Œstriden, Vienna, 1864.

CONOPIDÆ. Williston, Trans. Conn. Acad. iv, vi, 1882, 1885.

SYRPHIDÆ. Williston, Bull. National Museum, 31, 1886.

MUSCIDÆ ACALYPTRATÆ (*Ortalidæ*, *Trypetidæ*, *Sciomyzidæ*, *Ephydridæ*). Loew, Monographs, etc., i, iii, Smithsonian, 1862, 1873.

ANTHOMYIDÆ, HIPPOBOSCIDÆ, SARCOPHAGIDÆ, DEXIDÆ, etc. Bigot, Annales Soc. Ent. Fr. 1880–86.

NOTE ON A REMARKABLE FOSSIL.

BY ROBERT HAY, JUNCTION CITY, KAS.

Some time ago, on Sand creek, in Woodson county, a farmer's plow turned up what might be called a fine concretion in a district where concretions are plentiful. It was an oblate spheroid, very nearly a sphere, made of the hard clayey ironstone, so common in that region in the form of nodules. Its smallest circumference is 9 inches, its greatest circumference 9½ inches. Being so nearly a sphere, it was a boy's toy for six months, when a spirit of investigation being upon him, he broke it with an ax and showed the internal structure. It appeared to the boy and his friends to be a perfectly petrified walnut. The fracture made two concave hemispheres, out of which dropped the round nut broken into several pieces, showing internal septa. A few small fragments were lost, but the rest then fell into the hands of J. B. Stockton, of Toronto, by whose kindness the writer is permitted to submit it to the Academy. The outside portion of this petrifaction, to the thickness of five-sixteenths of an inch, is undoubtedly concretionary matter. Within that and closely adherent to it is another layer, that seems as certainly to be of organic origin. This layer is three-sixteenths thick, and seems of a fibrous structure like the outer rind of a walnut or hickory nut. The concave surface of this layer is irregularly marked with hard brown lines, which stand in slight relief from the rest, which is softer and yellowish in color. The spaces between the lines are wider near the poles of the sphere. This envelope shows no signs of segments in any direction. The outside surface of the included nut is marked by lines and spaces corresponding to those on the concavity of its envelope, but giving a much smoother surface, being somewhat smoother than the corresponding surface of an English walnut. This shell appears to be divided into three layers, having a total thickness of one-eighth of an inch, and a fourth layer another eighth, which sends off the septa across the nut. The principal septum is double. The internal cavities are hollow, having probably been filled, before the nut was broken, with some softer material, as dust or sand. The longest diameter —transverse to the septum—is one inch and five-eighths; the shortest, one inch and

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PANGONIA.

PANGONIA RASA Loew.

Three female specimens from Connecticut. The palpi in this species are very slender, and the legs of my specimens seem to be lighter colored than they are described.

PANGONIA TRANQUILLA Osten Sacken.

A male specimen from New York agrees well with the description; the palpi are noticeably shorter than in the males of any other species known to me.

PANGONIA FERA, n. sp.

Male: Length 12 mm. Black; eyes bare; proboscis longer than the tibiæ; basal segments of abdomen yellowish red on the sides and hind margin; wings brownish subhyaline, first posterior cell open; face brownish gray, with black pile; first two joints of antennæ black, with black hairs; palpi slender, black, with loose black hair; ocelli present. Proboscis black; labellæ small; dorsum of thorax brownish black, with some grayish dust, and blackish pile; pleuræ with some yellowish pile above; abdomen black, with black pile, the three basal segments broadly on the sides, and wholly on the venter, yellowish red; second, third and fourth segments with the posterior margin yellow, fringed with golden pile; wings brownish subhyaline, more distinctly clouded in front toward the stigma; costal and subcostal cells luteous yellow; legs wholly black, with black pile.

One specimen, Mt. Hood, Or. Is nearest allied to *P. tranquilla* O. S., but the more slender palpi and the black pilosity will readily distinguish it; the proboscis is also distinctly longer.

PANGONIA INCISURALIS Say (*P. incisa*, Wiedemann).

One specimen, from New Mexico. This species will be readily recognized by the elongate proboscis, small labellæ, fasciate abdomen, and closed first posterior cell.

PANGONIA CHRYSOCOMA Osten Sacken.

A single male specimen, from New York, is evidently of this species, though the sides of the abdomen are largely yellow. The author does not mention the slender yellow palpi, clothed with long, loose, black pile. The front tarsi, especially the first joints, are more slender than usual.

PANGONIA DIVES, n. sp.

Female: Length 13–15 mm. Head yellowish gray, the front more brownish. Antennæ reddish yellow, the annulate portion of the third joint largely black. Palpi yellowish red, at the base with light-colored pile, otherwise with short black, more or less intermixed with white hair. Proboscis about as long as the head, not extending much beyond the palpi, the labellæ large. Ocelli present. Dorsum of thorax covered with nearly uniform brownish or yellowish gray dust, nearly concealing the black ground-color; pubescence short, appressed, light yellowish. Pleuræ rather thickly gray pollinose and pilose. Scutellum like the thoracic dorsum, pile light yellow. Abdomen brownish yellow, the anterior part of the segments brownish or blackish, with more or less short black hair, the posterior part and margin with light yellow hair. Legs reddish yellow, the tibiæ somewhat, the tarsi more, brownish. Wings nearly hyaline, the costal and subcostal cells yellowish; all the posterior cells open, second submarginal cell appendiculate.

Male: Eyes distinctly pubescent. Face and the slender palpi with long, abundant, light yellowish hair, near the tip of the latter black. Thorax with rather abundant light yellow pile.

One male and four females, California. The eyes in life appear to be uniformly green, or purplish green. The basal abdominal segments of the male are only faintly brownish anteriorly, with a black spot, clad with black hair, near the middle. An-

other male, from Washington Territory, which I believe to be of the same species, is much darker, the abdominal segments dark reddish brown and black pilose, the hind margins yellowish, with a fringe of light yellow pile. The pile of the body seems longer, that on the dorsum of the thorax intermixed with blackish, and the black of the antennæ is better marked. The species is nearest allied to *P. pigra* O. S. There are, however, no dorsal thoracic stripes, the pollen being nearly uniform, the second submarginal cell is appendiculate, etc.

SILVIUS.

SILVIUS GIGANTULUS Loew.

This species seems to be very common in the West. I have specimens from Washington Territory, California, Colorado, and New Mexico.

SILVIUS QUADRIVITTATUS Say, Journ. Acad. Phil. iii, 33, 1; Compl. Wr. ii, 54 (*Chrysops*); Wiedemann, Auss. zweifl. Ins. i, 200, 9 (*id.*)

A female specimen from California agrees so well with the descriptions of this species that I refer it here. The chief ground for doubt in the determination, is the difference of locality, Say's specimen being from "Near the Rocky Mountains." This is, however, of little moment, in consideration of the fact that so many of the species of the Californian fauna reappear in Colorado. The species differs from S. *pollinosus* Will. in being darker throughout, in the antennæ being more slender, in the dorsum of the thorax having gray stripes on a black ground, and in the four abdominal stripes being better marked.

SILVIUS POLLINOSUS Williston, Trans. Connecticut Acad. iv, 244—Western Kansas.

Additional specimens of this species differ from the types in their much larger size (11–12 mm.) The wings have a whitish appearance and light-colored veins, the small clouds on the cross-veins darker and more conspicuous, with none on the course of the veins themselves. I hardly think it probable that this is the *Chrysops quadrivittatus* of Say and Wiedemann, since there are no blackish stripes on the dorsum of the thorax. As regards the generic location of both this and the preceding species, there may be a question. The structure is quite like that of *S. gigantulus*, but the general appearance is very different. The eyes, as revived over wet sand, show the characteristic markings of *Silvius*, that is, numerous irregularly scattered black dots over a green background. The species must resemble those of the European *Nemorius* Rondani, and may perhaps belong there. The third joint of the antennæ, however, is considerably longer than the first two together.

APATOLESTES.

Williston, Entom. Americana, i, 12, 1885.

APATOLESTES COMASTES Williston, l. c.—California.

CHRYSOPS.

SUPPLEMENTARY TABLE OF SPECIES.

1. Cross-band obsolescent; abdomen black ..... NIGRIBIMBO Whitney.
   Cross-band distinct 2
2. Apex of wing beyond cross-band hyaline 3
   Costal margin beyond cross-band more or less infuscated 4
3. Second basal cell infuscated on extreme basal part; abdominal segments with posterior gray borders ..... SORDIDUS O. S.
   Second basal cell largely infuscated; abdominal segments without posterior gray borders ..... CUCLUX Whitney.

4. First basal cell hyaline; first antennal joint thickened (San Domingo). FRAZARI, n. sp.
   First basal cell largely infuscated..... 5

5. Second basal cell infuscated on the proximal third or beyond..... 6
   Second basal cell hyaline..... 8

6. Prevailing color of body black; palpi blackish..... 7
   Prevailing color of body brownish yellow; palpi reddish..... FULVASTER O. S.

7. Abdomen wholly black..... PERTINAX, n. sp.
   Sides of first and second abdominal segments red..... NOCTIFER O. S.

8. First antennal joint distinctly thickened..... PACHYCERA, n. sp.
   First joint not distinctly thickened..... 9

9. A hyaline spot in the discal cell..... DISCALIS Will.
   No hyaline spot in the discal cell..... 10

10. Abdomen with four continuous black stripes..... SEQUAX, n. sp.
    Abdomen not striped..... 11

11. The black facial callosities small, not converging inferiorly..... PROCLIVUS O. S.
    The black facial callosities large, converging inferiorly; dorsum of thorax distinctly vittate..... SURDUS O. S.

CHRYSOPS EXCITANS Walker.

I have numerous specimens of this species from Washington, where it seems to be common, with others from Anticosti. The latter have no reddish yellow on the sides of the third abdominal segment, as is the case with the Western ones.

CHRYSOPS MITIS O. S.

A specimen from Montana agrees very well with the description of this species, except in size (9 mm.).

CHRYSOPS FUGAX Osten Sacken.

Specimens that I refer to this species I have from Anticosti, Massachusetts, and North Park, Colorado. Some of these specimens have the thoracic pollinose markings and the pubescent triangles of the abdomen well indicated, so that the presence of the small hyaline spot at the base of the fifth posterior cell — a slight character — is about all that can be relied upon to distinguish it from *C. mitis*. The Colorado specimen has the four posterior femora largely reddish at the base.

CHRYSOPS ÆSTUANS v. d. Wulp.— Western Kansas.

CHRYSOPS CALLIDUS Osten Sacken.

A single female specimen from Washington Territory, I am unable to satisfactorily distinguish from this Eastern species. The distal part of the costa is less distinctly clouded, and the cross-band less dark, especially posteriorly. The third and fourth abdominal segments are less dark, leaving only a pair of basal triangles.

CHRYSOPS PERTINAX, n. sp.

Female: Length 9–11 mm. Front gray, the large transverse callosity shining black. Face light yellow, the large callosities black, broadly coalescent above the oral margin, and separated from the shining black cheeks. Antennæ black, slender, first two joints reddish at base, and together about two-thirds as long as the third joint. Dorsum of thorax black, with two broad, median, anterior, greenish-gray stripes, limited by three slender brown ones. Abdomen shining black, in well-preserved specimens, with small median triangles of whitish pubescence, and with similar

pubescence on the posterior segments. Legs black, the four posterior tarsi a little reddish at base. Wings with dark-brown markings, filling out two-thirds or more of both basal cells, the cross-band not reaching the posterior margin, but including the base of the fifth posterior cell. The apical costal spot is diffuse, and reaches only a little way into the second submarginal cell, and is separated from the cross-band by the hyaline continuation of the halo, which reaches quite to the costa.

Eight specimens, Washington Territory. In some the legs are more brownish. The species approaches *C. celer* most closely, but will be at once distinguished by the apical costal cloud, and by the less bushy gray, not fulvous, pile of the pleuræ.

CHRYSOPS MOECHUS Osten Sacken.

One specimen from Cumberland Gap, and one without locality. The latter is on the same pin with a specimen of *C. pudicus* Osten Sacken.

CHRYSOPS FRAZARI, n. sp.

Female: Length 8 mm. Front yellowish gray, the large callosity black. Face grayish yellowish on its borders, elsewhere luteous yellow shining. Antennæ elongate, the first two joints together considerably longer than the third, the first joint considerably thickened; first joint reddish, second joint reddish brown, third black. Dorsum of thorax blackish brown, with four very distinct yellow pollinose stripes, the median ones remote, slender, broadly interrupted posteriorly, and contiguous on the front margin with the broader entire lateral ones. Pleuræ brownish black, with six distinct spots of yellow pollen, the smallest just above the front coxæ. Abdomen dark brown, the first segment with two small yellow pollinose spots on each side, the posterior ones obsolete; second segment with a median stripe, the large anterior angles reaching the whole length of the segment, and two spots behind, the next three segments each with three small, more or less confluent spots on the hind margin, the third segment with an additional median one in front. Wings almost pure hyaline, with distinctly limited dark-brown markings as follows: Anterior margin to the apex not, or but faintly, encroached upon in the marginal cell beyond the cross-band, the extreme base of both basal cells, and the cross-band, reaching to the hind margin at the tip of the first posterior and anal cells, leaving a hyaline sinus in the fifth posterior cell posteriorly. Legs luteous yellow, the knees and more or less of all the tibiæ, especially of the hind pair, and tarsi, brown or blackish; hind tibiæ with a distinct fringe of black pile outwardly. Venter dark brown, with two broad yellow stripes.

One specimen, San Domingo (G. F. Frazar).

CHRYSOPS SEQUAX, n. sp.

Female: Length 8, 9 mm. Front yellowish gray, the callosity black. Face mostly black, bare, reddish yellow, the callosities more or less black. Antennæ elongate, slender, the first joint longer than the second, the two together about as long as the third; first two joints yellowish, the third almost wholly black. Palpi yellowish or brownish. Dorsum of thorax with four broad, distinct stripes, the lateral ones more yellow, the median ones greenish yellowish gray and separated by a slender stripe. Pleuræ grayish yellow pollinose, with a longitudinal black stripe. Abdomen yellow, brownish or blackish distally, with four distinct black stripes reaching from or near the base, the lateral ones slender or partially obsolete anteriorly. Scutellum sometimes yellow on its border. Ventor yellow, with a broad median and a more slender lateral black stripe. First basal cell of the wings wholly filled out with brown, the second hyaline; the cross-band reaches the hind margin, but the fifth posterior cell is largely hyaline at its base; anal cell open; wings broadly clouded distally, including nearly all of the second submarginal cell, and encroaching upon the first posterior, the hyaline arcuation between the cross-band and spot slender, scarcely transcending

the second longitudinal vein. Legs yellow or brownish yellow, the knees, distal part of front tibiæ, their tarsi, and the base of hind femora, black; sometimes the base of middle femora, the tip of their tibiæ, and the whole hind legs, except the base of the tarsi, black.

Male: Black abdominal stripes stronger and more distinct, the median ones more coalescent on the first and anterior part of second segment; the wings darker, with the second basal cell almost wholly brown, the only wholly hyaline portions being at the outer end of the second basal cell, encroaching upon the base of the fifth posterior cell, and the slender crescentic spot beyond the cross-band.

Four females and one male, Western Kansas.

CHRYSOPS PLANGENS Wiedemann.

Specimens of this species from Georgia, though smaller, agree in other respects with ones from Connecticut.

CHRYSOPS SORDIDUS Osten Sacken.

Two specimens of this species from the White Mountains, while agreeing well with the description, would not be correctly located in Osten Sacken's table, by reason of the slight infuscation at the base of the second basal cell.

CHRYSOPS CUCLUX Whitney, Can. Entom. xi, 35.

This species, (closely allied to *C. sordidus*, according to the author,) I do not know.

CHRYSOPS CURSIM Whitney, Can. Entom. xi, 36.

I do not see wherein this species differs from *C. pudicus* Osten Sacken.

CHRYSOPS SURDUS Osten Sacken.

Specimens from California agree very well with the description, but others, from Washington Territory, have the yellow of the face extending to the oral margin in front, and the grayish stripes of the thorax extending distinctly the whole length of the dorsum. The third and following abdominal segments have a narrow posterior yellow margin, and the third and fourth segments have each a median stripe.

CHRYSOPS PROCLIVUS Osten Sacken.

Specimens from California, Washington Territory, and Mt. Hood, Oregon, agree very well with the description.

CHRYSOPS FULVASTER Osten Sacken.

Numerous specimens from Colorado and Montana I identify with this species, though there is some variation among them. In the Montana specimen the second abdominal segment is chiefly blackish, with the posterior margin, a median expansion, and the anterior angles yellowish. In the males the segments have each a small yellow median posterior expansion. Osten Sacken omits a striking characteristic of the species, viz., the thickening of the first antennal joint. Near the close of his description of the female, "fourth posterior" should read fifth posterior.

CHRYSOPS DISCALIS Williston, Trans. Connecticut Acad., iv, 245.

CHRYSOPS COSTATUS Fabr.

San Domingo. Belongs to the group with a hyaline spot in the discal cell; it has, also, very slender antennæ.

CHRYSOPS PACHYCERA, n. sp.

Female: Length 8, 9 mm. Facial callosities yellow (probably with blackish in some specimens). Front, yellow; the callosity shining reddish-yellow, somewhat margined with blackish above. Antennæ elongate, the first two joints together longer

than the third; first joint swollen, yellow; second joint a little darker; third, except the base, black. Dorsum of thorax with browish-yellow pollen, the median geminate stripes separated by a shining black interval from the more yellow lateral margins. Abdomen: The two basal segments yellow; the first with a transverse black spot below the scutellum, the second with two oval divergent spots, and toward the posterior margin, on the outer side, with a small rounded spot; third, fourth, and fifth segments each with four elongate spots (those of each lateral pair of the third may be coalescent in front), not reaching the hind margin. Venter with a broad median and a slender lateral black stripe. Legs yellow, the knees, distal part of front tibiæ, and the front tarsi, blackish. First basal cell infuscated upon its basal two-thirds, the second on its basal third; the cross-band reaches the hind margin, leaving a small hyaline space in the fifth posterior cell, the discal cell not lighter; the apical spot fills out the marginal cell completely, and reaches into the second sub-marginal.

Male: Antennæ a little darker, the first two joints not as long together as the third, the first joint less swollen. Abdomen black, the narrow lateral margins of the anterior segments yellow, extending in on the hind margin of the first segment and across the hind margin of the remaining ones; the second, third, and fourth segments each with three small triangular expansions on the hind margin. Front and hind legs chiefly black, the middle legs chiefly, and the base of the hind tarsi, yellow. Wings darker, the second basal cell infuscated, but with a subhyaline stripe along the middle; discal cell with a subhyaline spot.

Three specimens, California: The difference in the antennæ and the hyaline spot in the discal cell make the union of the two sexes as above described, somewhat doubtful. The species is allied to *C. fulvaster*, but will be distinguished by the lateral yellow spots on the abdominal segments, etc.

HÆMATOPOTA.

HÆMATOPOTA AMERICANA Osten Sacken.

A specimen from California has the four posterior metatarsi with only a vestige of white color at the base, but otherwise agrees very well with the description, excepting that I would hardly describe the first antennal joint as "very much incrassated." The wide distribution of the species renders it probable that it is identical with Macquart's *H. punctulata* from Carolina.

TABANUS.

SUPPLEMENTARY TABLE OF SPECIES.

1. Eyes pubescent 15
   Eyes bare 2

2. Abdomen with definite white markings 3
   Abdomen without definite white markings 14

3. The white markings of the abdomen consist of a single row of triangles, or a median stripe 4
   The white markings consist of two or three rows of triangles or spots 10
   Abdomen brownish reddish, with whitish posterior borders to the segments. ANNULATUS Say.

4. Wings distinctly spotted or clouded with brown 5
   Wings without distinct clouds on the cross-veins; prevailing color of antennæ black; dark species ..... SODALIS, n. sp.

5. Very small species; abdomen with a whitish stripe and incisures (San Domingo.) PARVULUS, n. sp.
   Abdomen with triangles; larger species 6

6. Antennæ red; veins of wings clouded 7
Antennæ largely black 9

7. Frontal callosity nearly square; annulate portion of third joint short.. FUR, n. sp.
Frontal callosity very narrow; annulate portion of antennæ very long.
TURBIDUS Wied.

8. First posterior cell closed; front remarkably narrow ..... ABDOMINALIS Fabr.
First posterior cell open 9

9. Abdominal triangles of moderate size ..... EXUL O.S.
Abdominal triangles large ..... SULCIFRONS Macq.

10. The lateral spots of the abdomen touch the hind margin 11
The lateral spots do not touch the hind margin; small species 13

11. Middle sized, elongate species ..... GRACILIS Wied.
Small species; third antennal joint broad 12

12. Frontal callosity not denuded ..... PYGMÆUS, n. sp.
Frontal callosity denuded ..... SPARUS Whitney.

13. Basal part of third joint broad ..... PUMILUS Macq.
Basal part of third joint narrow; darker ..... FRATELLUS, n. sp.

14. Wings nearly hyaline ..... ÆGROTUS O.S.
Wings brown in front (San Domingo) ..... FENESTRA, n. sp.

15. Abdomen black, without red on the sides 16
Abdomen more or less broadly red on the sides 17

16. Abdominal segments with a narrow hind border of whitish dust and pubescence, expanding into median triangles ..... SEQUAX, n. sp.
Abdomen without grayish borders or triangle; thickly pilose, thick-set species.
PROCYON O.S.

17. Palpi dark; abdomen red with a median black stripe ..... MEGERLEI Wied.
Palpi light yellow ..... 18.

18. Prevailing color of antennæ red; front convergent anteriorly.... COMASTES, n. sp.
Prevailing color of antennæ black ..... 19.

19. Front gray ..... PHÆNOPS O.S.
Front brownish ..... SONOMENSIS O.S.

The following species, published since the appearance of Osten Sacken's catalogue, I do not know:

TABANUS SUPERJUMENTARIUS Whitney, Can. Entom. xi, 37. New Hampshire.

TABANUS DODGEI Whitney, Can. Entom. xi, 37. Nebraska.
"Eyes pubescent; ocellar tubercle wanting; abdomen brown, with two broad white stripes of subequal width with the space between. Wings hyaline, 12–14 mm."

TABANUS ALLYNI Marten, Can. Entom. xv, 110. North Carolina.
Eyes bare; abdomen broadly yellow on the sides; 15 mm.

TABANUS TETRICUS Marten, Can. Entom. xv, 111. Montana.
A *Therioplectes* of the group of *T. rhombicus*, with denuded subcallus.

TABANUS FRENCHII Marten, Can. Entom. xv, 111. Montana.
A *Therioplectes* allied to *T. microcephalus* apparently. The black face with white hair is rather peculiar.

TABANUS SUSURRUS Marten, Can. Entom. xv, 111. Montana.

Evidently allied to *T. rhombicus* (*Therioplectes.*)

A. Eyes pubescent, *THERIOPLECTES.*

TABANUS AFFINIS Kirby.

A single, somewhat rubbed specimen, from Colorado, seems to be of this species.

TABANUS RHOMBICUS Osten Sacken.

A number of species from Colorado agree so well with the description of this species that I feel quite sure of my determination. They belong, however, in the two groups described by Osten Sacken in his Western Diptera (p. 218), agreeing well with the characters there given, except that I can perceive no difference in the subcostal cell. It would seem probable that there are distinct species among them, yet specimens of the two forms were collected together in North Park. *T. susurrus* Marten must be closely allied, though the prominent angle of the antennæ seems to indicate a distinct species.

TABANUS SEQUAX, n. sp.

Female: Length 14–16 mm. Front of nearly equal width, brownish, with black pile; callosity squarish or subcordate, black; extending above into a line; subcallus not denuded. Antennæ wholly deep black, the annulate portion of the third joint about three-fifths as long as the basal portion; angle obtusely projecting. Face gray, with whitish pile. Palpi grayish black, with black hair. Dorsum of thorax grayish black, with rather abundant, mostly black pile, and two not very distinct grayish stripes anteriorly; a tuft of white pile on the post-alar callosities. Pleuræ with white pile. Abdomen black, the segments with a narrow hind border of whitish dust and pubescence, interrupted on each side of the small median triangular expansion. Legs black, the base of four anterior tibiæ faintly reddish. Wings hyaline, the cross-veins and furcation of third vein with small but distinct brown clouds.

Three specimens, Mt. Hood, Oregon. The eyes in this species are distinctly pubescent, and the vertex has a partially denuded tract, though I cannot distinguish any ocellar tubercle.

TABANUS COMASTES, n. sp.

Female: Length, 14–16 mm. Face yellowish-gray, with similarly colored pile. Palpi moderately stout, yellow, with black hairs. Antennæ red, the annulate portion black, the basal joints more or less blackish; basal portion broad, a little longer than the annulate portion, the angle moderately projecting. Front convergent anteriorly, yellowish or grayish-brown, with black pile; callosity nearly square, black, subcallus denuded, shining black; ocellar tubercle distinct. Dorsum of thorax grayish brownish black, with fulvous pubescence and black pile; ante-alar callosity reddish. Pleuræ gray, with grayish pile. Abdomen black in the middle, expanding anteriorly, and on the fifth and following segments; broadly yellowish or brownish red on the sides; the posterior margins of the segments (expanding a little in the middle of the anterior segments) lighter yellow, with a fringe of golden pile. Venter yellowish red, black distally. Legs black, the base of the front tibiæ, and the four posterior femora distally, their tibiæ and tarsi (except their brownish distal parts), reddish yellow; hind tibiæ black ciliate. Wings nearly hyaline.

Male: The basal portion of the third antennal joint narrower, more excised above, and with the angle more drawn out. Eyes, thorax and legs more thickly pilose.

Five females and one male from Washington Territory and Mt. Hood, Oregon. The species resembles *T. lasiophthalmus*, but will be at once distinguished by the absence of brown clouds on the wings. The black on the second and third abdominal segments might better be described as forming two rounded or quadrate spots;

on the fourth the black is more extensive, and on the fifth there may be some reddish as well as the lateral margins.

TABANUS CINCTUS Fabricius.

This species is common in Connecticut, and is very conspicuous by reason of the bright yellow basal part of the abdomen. Baron Osten Sacken rather incorrectly describes the color as yellowish red.

TABANUS REINWARDTII Wiedemann.—Western Kansas.

TABANUS MEGERLEI Wiedemann.

The possession of two specimens of this species in good condition, from Florida, enables me to give a more complete description, as follows:

Female: Length 17–20 mm. Antennæ deep red, the annulate portion of third joint blackish, the angle of the third joint produced into a long slender process. Face yellowish brown, with brown pile. Front brown, below the callosity yellowish white, of nearly equal width; callosity nearly black, scarcely higher than broad. Palpi yellowish, clothed with black hairs, giving them a brownish appearance. A patch of black pile at the denuded vertex. Eyes distinctly pubescent. Dorsum of thorax brownish-black, reddish on the sides, with fulvous pubescence and indistinct grayish stripes. Pleuræ black, somewhat reddish in the middle, with black pile. Abdomen yellowish red; a broad black stripe, obscurely narrowed on the second and third segments, the lateral margins also black; the fulvous portion has fulvous pubescence in front, whitish pubescence and pollen behind. Venter yellowish and brownish red, with abundant silvery pollen and pile. Legs dark reddish brown, the femora more blackish. Wings brown on the proximal part, the cross-veins and furcation of third vein with dark-brown clouds.

TABANUS INSUETUS Osten Sacken.

A single specimen from North Park, Colorado, agrees so closely with the description of this species, that I have little or no doubt of the identity, notwithstanding the difference in locality.

B. Eyes bare, TABANUS.

TABANUS TURBIDUS Wiedemann.

A female specimen from Alabama is evidently of this species, but the angle of the third antennal joint is distinctly drawn out into a point.

TABANUS FRONTO Osten Sacken.

A female from Florida, evidently of this species, is nineteen millimeters in length, the abdomen is largely blackish posteriorly, and the first posterior cell is closed.

TABANUS ABDOMINALIS Fabricius.

TABANUS EXUL Osten Sacken.

Specimens of the above two species from Kentucky and Virginia leave no doubt of the propriety in separating them on the frontal width and the open first posterior cell.

TABANUS SULCIFRONS Macquart (*tectus* O. S.)

Two specimens from Louisiana agree with the ones described by Osten Sacken from Texas in having the abdomen flattened, and with a white spot on the sixth segment. One of them measures only 15 mm.

TABANUS RECEDENS Walker (*T. catenatus* O. S. non Walker.)

Although it is a sad commentary on justice to recognize or give preference to Walker's name, yet I do not think it feasible to retain the name *T. catenatus* O. S.,

and thus infract two decided laws in zoölogical nomenclature. I have taken the males in Connecticut several times while feeding on *Cirsum*.

TABANUS MELANOCERAS Wiedemann.

To a single specimen from Georgia Wiedemann's description applies well, but a number of other specimens from Florida differ in their less hyaline wings, in the presence of small but distinct brownish clouds on the cross-veins, and a dark brown border to the stigma. They would be brought to *T. molestus* Say by Osten Sacken's table, but that they are not this species is evident from the coarctate first posterior cell and the presence of large-sized triangles on the second abdominal segment. The color of the thoracic dorsum is also often more reddish in the Florida specimens.

TABANUS NIGRESCENS Palisot Beauvois.—Virginia.

TABNAUS ÆGROTUS Osten Sacken.

I have several males and females of this species, from Oregon and California, varying in length from 17 to 23 mm. The head of the male is large and convex, but the large and small facets are not distinctly separated, or very different in size.

TABANUS PUNCTIFER Osten Sacken.

All my specimens (California, Washington) of this easily recognizable species have the first posterior cell coarctate, as in some specimens of *T. stygius*, which I have from as far west as Kansas.

TABANUS GIGANTEUS Degeer.

This species I observed in extraordinary abundance at Vandalia, Ill., in the early part of September, causing much worry and annoyance to stock in the woodlands. I have it also from Florida.

TABANUS SODALIS, n. sp.

Female: Length, 15, 16 mm. Brownish black. Abdomen with a single row of conspicuous white triangles; wings without distinct clouds on the cross-veins; third joint of antennæ red at the base; first posterior cell not coarctate; eyes bare. Abdomen rather broadly oval; second, third, and fourth segments each with a large white triangle, expanding from a narrow posterior border, largest on the second, the fifth with only a small whitish spot, the first with a small but distinct one. Venter dark brown, broadly whitish pubescent and pollinose on the sides and the narrow posterior borders. Palpi whitish, with minute black and white hairs. Face and front yellowish white, the former with yellowish white pile. Frontal callosity nearly black, squarish, above it, and separated from it, a slender bare spot; front of nearly equal width. Antennæ black, the third joint red at the base, the upper angle moderately projecting, forming about a right angle, the annulated portion about two-fifths of the entire length. Dorsum of the thorax grayish brownish black, the ante-alar callosity red; pollinose stripes moderately distinct. Legs dark brown or black, the base of the tibiæ more or less luteous or reddish. Wings tinged with brownish, more distinctly so in the neigborhood of the stigma.

This species is nearest related to *T. coffeatus*, but will be at once distinguished by the presence of four bright green narrow horizontal stripes on the purple background of the eye. From *T. molestus* and *T. trimaculatus* the large triangle on the second abdominal segment will readily separate the species.

TABANUS FUR, n. sp.

Female: Length 17 mm. Abdomen with a single row of white triangles; wing cross-veins distinctly clouded with brown; legs red, the tarsal joints a little darker; angle of third antennal joint not produced.

Resembles *T. recedens* Walker, but is smaller; the annulate portion of the third antennal joint is shorter, not or scarcely a third of the length of the joint; the dorsum of the thorax is lighter colored, the markings less distinct, the pile of the pleuræ less abundant, the abdomen lighter colored, etc. The abdomen is ferruginous red, with a single row of rather narrow triangles; it is attenuated posteriorly, but less so than in *T. recedens*. Wings tinged with brownish, the veins broadly and diffusely clouded with brownish, the cross-veins very distinctly clouded with brown; first posterior cell coarctate. From *T. turbidus*, under which it would be sought for in Osten Sacken's table, and with which it might perhaps be best compared, the nearly square frontal callosity and the short annulate portion of the third antennal joint will immediately separate it. Two specimens, Florida.

TABANUS SPARUS Whitney, Can. Entom. xi, 38.

This species is closely allied to *T. pumilus*, and only by a careful examination is one able to distinguish it in the dried specimens. I have a number of specimens of *T. sparus* from Connecticut and Massachusetts, (July 1,) and three of *T. pumilus* from Indiana. In all of the former the lateral whitish spots of the second and third abdominal segments are broadly contiguous with the hind margins, while in the latter they form on all the segments, small, oval, isolated spots. Most distinctively characteristic of the two species, however, are the color-markings of the eyes, as I can corroborate from the revivification of my dried specimens. *T. pumilus* has two bright green stripes on purple ground, while in *T. sparus* the eyes are wholly light green with a purple reflection.

TABANUS FRATELLUS, n. sp.

Female: Length 8–9 mm. Abdomen with three series of isolated spots; wings hyaline; antennæ narrow; small species.

Palpi slender, white, with minute black hairs. Face grayish white, with white pile. Front brownish gray, convergent anteriorly; callus nearly square, black, with a larger, shield-shaped, shining spot above it. Antennæ blackish brown, the basal portion of third joint sometimes reddish brown, narrow, only a little wider at base of non-annulate portion, the angle feebly indicated. Thorax grayish black, with three well-indicated narrow gray stripes; pleuræ gray, with whitish pile. Abdomen black, with well-marked whitish hind borders to the segments; segments two-five each, with three small, rounded, transverse, whitish spots. Venter with grayish dust, and posterior whitish hind borders to the segments. Legs black, the base of front tibiæ, and the most of the four posterior tibiæ yellowish; four posterior tarsi brownish. Wings hyaline, stigma brown; first posterior cell open.

Two specimens, Washington Territory. The species closely resembles *T. pumilus*, but is darker, and the antennæ are much narrower at the base of the third joint, with the angle feebly indicated.

TABANUS GRACILIS Wiedemann, Auss. zweifl. Ins. i, 156, 71; Osten Sacken, Cat. Dipt., note 81, p. 228.

I recognize this species in a number of specimens from Florida. They agree well with Wiedemann's description, except in the color of the antennæ, which are either wholly red, or with the annulate portion brown. The slenderness, pale but distinct brown clouds on the veins of the wings, and general light color—lilac-reddish—throughout, will distinguish it. Osten Sacken, from an examination of the faded type, compared the species with his *T. longus*. From the description, indeed, it seems to be nearly related to that species, though differing in the lighter color, and brownish clouds on the wings. The lateral spots of the abdominal segments, in all my specimens, reach distinctly to the hind margin, the only thing that prevents

the species being brought to *T. longus* in Osten Sacken's table. The prevailing color of the abdomen is brownish-red. Their length is 12, 13 mm.

TABANUS PYGMÆUS, n. sp.

Female: Length 6 mm. Third antennal joint broad oval, not angulated, annulated portion short; frontal callus not denuded; tibiæ light yellow at base. Front rather broad, not narrowed anteriorly, callosity wanting or not denuded, in color light grayish yellowish. Face yellowish white, with white pile. Palpi white, not slender, with white hairs. Antennæ brownish red, the third joint short, basal portion large, only a little longer than broad, gently convex below and obtusely angulated in the middle above; annulate portion very short, not a third the length of the joint. Thorax grayish brown, with three slender lighter stripes. Abdomen light chocolate brown, with a large, oblique, posteriorly contiguous triangle, and a less distinct median triangle on the segments, grayish yellowish. Legs black, the base of the four anterior tibiæ whitish yellow, hind tibiæ, except the tip, and the base of the four posterior tarsi, yellow, the remainder of these tarsi brown. Wings hyaline, stigma brownish.

One specimen, Florida. The eyes appear to be in life green on the upper, purple on the lower portion.

TABANUS PARVULUS, n. sp.

Female: Length 7 mm. Front narrow, parallel; base of third antennal joint red; abdomen with a median stripe, and the incisures light yellowish; tibiæ yellow at base; wings with dark brown clouds on the cross veins.

Frontal callosity black, a little higher than broad, with a slender prolongation above. Antennæ red, the first joint and the annulate portion black, the latter nearly as long as the base of the joint, basal portion not broad, obtusely angulated. Face yellowish gray. Thorax yellowish gray, the dorsum with three broad reddish-brown stripes. Abdomen brown, the segments with distinct narrow, light yellowish hind margins, dilated in the middle into an uninterrupted narrow stripe, reaching from the base of the abdomen to the seventh segment. Legs brownish black, the base of the tibiæ, including a third of the front and two-thirds of the hind pair, yellow, the base of four posterior tarsi likewise yellow. Wings nearly hyaline, the narrow front border, becoming broader and more diffuse on the apex, brownish; all the cross-veins with narrow but strong brown clouds; second submarginal cell appendiculate.

One specimen, San Domingo. Singularly, the palpi are entirely wanting in my specimen, though there is no indication of the specimen having been injured.

TABANUS FENESTRA, n. sp.

Female: Length 13 mm. Black; front narrowed anteriorly; thorax chocolate brown; all the tibiæ light yellow; wings hyaline, the anterior and outer part brown, the latter with hyaline streaks.

Front yellowish gray, much narrowed anteriorly; the callus small, oval, continued above as a line; subcallus partly denuded. Face grayish yellowish, with whitish pile. Palpi black, second joint short and thick. Antennæ brownish red, the basal joints and annulate portion darker; basal portion of the third joint not very broad, the angle not salient. Dorsum of thorax chocolate brown, more or less grayish pollinose, pleuræ with black hair. Abdomen brownish black, with grayish bloom. Middle and hind femora dark brown, front femora brownish; all the tibiæ light yellow, the hind pair somewhat infuscated at tip; front tarsi light reddish yellow, posterior pairs darker. Wings subhyaline brown along the front part and at the tip; in the marginal and submarginal cells with light streaks; second submarginal cell appendiculate.

San Domingo. The eyes, as restored, show two horizontal green stripes on a greenish purplish background.

TABANUS ANNULATUS Say.

A specimen from Louisiana agrees very well with Wiedemann's description, though it does not have the dark abdomen as Say describes.

METEOROLOGICAL SUMMARY FOR THE YEAR 1886.

PREPARED BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS, FROM OBSERVATIONS TAKEN AT LAWRENCE.

The year 1886 was marked by an excessively cold January, a long, hot summer, a dry atmosphere, light winds, and clear skies. But the most remarkable characteristic of the year was the very light rainfall of its second half. Up to the 1st of July the rainfall was only 1.79 inches below the average, but for the remainder of the year there was a deficiency of 9.23 inches, the total precipitation being less than half the normal amount. Although the total rainfall was much less than in any previous year of our record, the copious rains of the first six months secured good crops of wheat and half crops of corn in the districts most seriously affected by the drouth.

TEMPERATURE.

Mean temperature of the year 52.96°, which is .04° above the mean of the eighteen preceding years. The highest temperature was 105°, on August 16th; the lowest was 18° below zero, on the 9th of January, giving a range of 123°. Mean at 7 A. M., 47.13°; at 2 P. M., 62.16°; at 9 P. M., 51.28°.

Mean temperature of the winter months 23.33°, which is 5.88° below the average winter temperature; of the spring 54.57°, which is .96° above the average; of the summer 76.80°, which is .96° above the average; of the autumn 57.17°, which is 3.39° above the average.

The warmest month of the year was July, with mean temperature 79.54°; the warmest week was August 11th to 17th, mean 86.93°; the warmest day was August 16th, mean 90.62°. The mercury reached or exceeded 90° on 53 days, (13 more than the average number,) viz.: two in May, three in June, twenty-one in July, eighteen in August, and nine in September. There were five days on which the temperature exceeded 100°—one in July and four in August.

The coldest month was January, with mean temperature 14.32°; the coldest week was January 6th to 12th, mean temperature .61° below zero; the coldest day was January 8th, mean 12.75° below zero. The mercury fell below zero on 16 days, of which 10 were in January, 3 in February, and 3 in December.

The last hoar frost of spring was on April 27th; the first hoar frost of autumn was on October 1st; giving an interval of 155 days, or over 5 months, entirely without frost. This is precisely the average interval.

The last severe frost of spring was on April 5th; the first severe frost of autumn was on the 27th of October; giving an interval of 203 days, or nearly 7 months, without severe frost. The average interval is 198 days. No frosts during spring and autumn caused damage to crops of grain and fruit, but the low temperatures of January were universally destructive to peach buds.

RAIN.

The entire rainfall, including melted snow, was 24.25 inches, which was 11.02 inches below the annual average. Either rain or snow, or both, in measurable quan-

tities, fell on 103 days—one less than the average. On 15 other days, rain or snow fell in quantity too small for measurement.

The number of thunder showers was 28. There was but one light hail storm during the year.

The drouth which prevailed during July, August and September was the only serious drouth in Kansas since 1874. From June 26th to July 24th, an interval of 27 days, there was an entire absence of rain. From the same date to September 16th, a period of 81 days, the rainfall was but 2.85 inches. In 1874 the drouth extended from June 14th to September 3d, an interval of 80 days, during which the rainfall was only 2.19 inches. Thus the drouth of '86 was one day longer than that of '74, but the latter began nearly two weeks earlier in the season, and was therefore more disastrous in its effects.

SNOW.

The entire depth of snow was 23.50 inches, which is 1.96 inches above the average. Of this amount twelve inches fell in January, one inch in February, four inches in March, four inches in April, half an inch in November, and two inches in December. Snow fell on 31 days. The last snow of spring was on March 27th. The first snow of autumn was on November 11th—three days later than the average date.

FACE OF THE SKY.

The mean cloudiness of the year was 39.64 per cent., which is 4.99 per cent. below the average. The number of clear days (less than one-third cloudy) was 189; half clear (from one to two-thirds cloudy), 91; cloudy (more than two-thirds), 85. There were 59 days on which the cloudiness reached or exceeded 80 per cent. There were 64 entirely clear and 39 entirely cloudy days. The clearest month was October, with a mean of 25.91 per cent.; the cloudiest month was January, mean 61.93 per cent. The percentage of cloudiness at 7 A. M. was 44.03; at 2 P. M., 44.46; at 9 P. M., 30.44.

DIRECTION OF THE WIND.

During the year, three observations daily, the wind was from the N. W. 227 times, S. W. 221 times, S. E. 172 times, N. E. 157 times, S. 137 times, N. 77 times, E. 65 times, W. 39 times. The south winds (including southwest, south, and southeast) outnumbered the north (including the northwest, north, and northeast) in the ratio of 530 to 461.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 127,769, which is 9,070 miles below the annual average for the preceding 13 years. This gives a mean daily velocity of 350.03 miles and a mean hourly velocity of 14.58 miles. The highest velocity was 70 miles an hour, on March 21st; the highest daily velocity—the second highest on our record—was 1,120 miles, on the 8th of January; the highest monthly velocity was 13,900 miles, in March. The windiest months were January, March, April and November; the calmest months were May, June, July and August. The average velocity at 7 A. M. was 12.56 miles; at 2 P. M., 16.06 miles; at 9 P. M., 13.77 miles.

BAROMETER.

Mean height of barometer column, 29.111 inches, which is .004 inch above the annual average. Mean at 7 A. M., 29.128 inches; at 2 P. M., 29.092 inches; at 9 P. M., 29.114 inches; maximum, 29.788 inches, on December 4th; minimum, 28.482 inches, on February 9th; yearly range, 1.306 inches. The highest monthly mean was 29.254 inches, in December; the lowest was 29.037 inches, in July. The barometer observations are corrected for temperature and instrumental error only.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 66.5; at 7 A. M., 76.9; at 2 P. M., 50; at 9 P. M., 72.5. The dampest month was January, with mean humidity, 83; the driest month was July, mean humidity, 58.4. There were only 5 fogs during the year. The lowest humidity for any single observation was 16 per cent., on November 2d and 22d.

The following tables give the mean temperature, the extremes of temperature, the number of inches of rain and snow, the number of rainy days, the number of thunder showers, the mean cloudiness, the relative humidity, the number of fogs, the velocity of the wind, the mean and extreme barometer heights, for each month of the year 1886, and a comparison with each of the 18 preceding years.

YEAR 1886.

1886.	Mean temperature	Maximum temperature	Minimum temperature	Rain, inches	Snow, inches	Rainy days	Thunder storms	Mean cloudiness	Humidity	No. of fogs	Miles of wind	Mean barometer	Maximum barometer	Minimum barometer
January	14.32	41.5	-18.0	2.28	12.0	15	0	61.93	83.0	2	13,090	29.200	29.721	28.627
February	31.64	62.0	-7.0	0.56	1.0	7	1	42.38	73.6	2	11,170	29.166	29.725	28.482
March	40.40	79.0	11.0	1.63	4.0	10	1	55.05	67.7	0	13,900	29.069	29.510	28.589
April	54.80	85.0	19.0	1.38	4.0	12	2	52.66	65.1	1	13,040	29.053	29.427	28.640
May	68.50	91.0	44.0	5.72	0.0	9	6	34.52	67.9	0	7,920	29.024	29.322	28.620
June	71.85	92.0	49.0	3.71	0.0	12	3	38.00	68.4	0	6,372	29.052	29.437	28.804
July	79.54	100.0	57.0	0.11	0.0	4	2	31.83	58.4	0	6,857	29.037	29.183	28.853
August	79.02	105.0	51.5	2.49	0.0	11	6	28.60	60.1	0	8,840	29.048	29.214	28.861
September	71.19	97.0	42.0	2.34	0.0	8	3	32.00	60.7	0	10,315	29.090	29.377	28.731
October	60.23	86.0	27.0	1.59	0.0	4	3	25.91	59.1	0	10,865	29.219	29.416	28.795
November	40.08	76.0	15.0	1.61	0.5	5	1	35.11	63.6	0	13,230	29.121	29.551	28.523
December	24.03	58.0	-6.0	0.83	2.0	6	0	37.77	73.4	0	12,170	29.254	29.788	28.825
Mean	52.96	81.0	23.7	2.02	2.0	9	3	39.64	66.5	.04	10,647	29.111	29.473	28.696

NINETEEN YEARS, 1868-1886.

Year	Mean temperature	Maximum temperature	Minimum temperature	Hot days, above 90°.	Zero days	Days between severe frosts	Rain, inches	Snow, inches	Rainy days	Thunder storms	Mean cloudiness	Humidity	Number of fogs	Miles of wind	Mean barometer
1868...	52.77	101.0	-16.5	43	7	160	37.48	27.50	77	.....	42.35	.....	.....	.....	.....
1869...	50.51	96.0	-5.0	23	2	167	38.51	18.00	105	33	49.23	78.2	19	.....	29.103
1870...	53.70	102.0	-10.0	51	6	197	31.32	9.50	100	27	47.88	68.4	13	.....	29.097
1871...	53.56	103.0	-6.0	48	8	218	33.23	29.75	120	24	47.37	65.9	6	.....	29.076
1872...	51.30	97.0	-18.0	45	16	192	32.63	23.25	116	40	44.33	64.4	11	.....	29.112
1873...	51.96	104.0	-26.0	48	9	165	32.94	26.50	101	17	42.46	64.0	6	154,508	29.098
1874...	53.68	108.0	-3.0	58	2	187	28.87	43.00	99	20	45.54	65.7	14	145,865	26.121
1875...	50.60	99.0	-16.5	32	12	196	28.87	5.00	106	21	44.81	66.7	5	145,316	29.102
1876...	52.76	98.0	-5.0	36	4	179	44.18	25.75	102	29	41.27	66.8	4	148,120	29.102
1877...	54.16	99.0	-9.0	20	3	217	41.09	15.50	126	39	47.12	72.6	11	113,967	29.117
1878...	55.33	98.0	-6.0	35	7	228	38.39	25.50	107	38	40.65	70.2	5	125,793	29.067
1879...	54.67	99.5	-16.0	48	13	203	32.68	10.35	90	36	40.01	67.1	10	124,768	29.127
1880...	54.01	101.0	-12.0	41	2	211	32.65	7.00	89	29	40.15	67.9	18	146,039	29.123
1881...	54.65	104.0	-8.0	68	6	210	33.27	32.50	110	31	47.42	70.1	11	141,430	29.103
1882...	54.94	105.0	-6.5	40	1	232	27.60	18.00	102	26	45.41	68.6	14	137,736	29.113
1883...	51.66	96.5	-14.0	26	8	217	40.65	12.50	106	32	45.24	69.7	18	141,164	29.135
1884...	51.30	98.0	-21.5	20	14	198	43.70	29.00	105	35	47.56	72.6	28	131,188	29.111
1885...	51.01	96.0	-14.5	27	21	176	36.97	33.00	103	31	44.57	71.3	9	123,013	29.107
1886...	52.96	105.0	-18.0	53	16	203	24.25	23.50	103	28	39.64	66.5	5	127,769	29.111
Mean,	52.92	100.5	-12.2	40	8	198	34.70	21.85	104	30	44.37	68.7	12	136,191	29.107

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BY F. W. CRAGIN, LIBRARIAN.

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As below given, the catalogue includes all that has come into the hands of the Librarian up to the 20th of June, 1887.

JOURNALS, PERIODICALS, ANNUAL REPORTS, ETC.

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Same. Third Annual Report. 1875 [9].
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